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ABSTRACT

The mathematics curriculum of the Fort Benton school system was designed with funds under Title III of the Elementary and Secondary Education Act to present all students with a basic knowledge of mathematics and to provide the gifted child with an opportunity to develop to the best of his ability the mathematical skills and theory demanded by a technological society. Basic goals of the curriculum include development of a knowledge of mathematical concepts, the skill of computation, an understanding of mathematical terminology, and a knowledge of career opportunities in mathematics. The curriculum consists of a sequential program for grades K-12 which includes algebra, geometry, and consumer mathematics. Objectives and instructional resources are specified for each grade level. (JH)

FORT BENTON MATHEMATICS CURRICULUM OUTLINE

math

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PREFACE

The means by which a small rural school system might provide a continuing curriculum development process are limited fiscally in most areas of Montana. Through the acquisition of a federal grant under ESEA Title III, we in the Fort Benton System have been able to overcome this limitation to some degree. Found in the pages of this curriculum outline are the efforts of Fort Benton teachers and administrators as well as the efforts of personnel from seven other Montana schools.

In today's paper world we often measure success by the volume of the printed word. The efforts put forth by the people involved in this project in no way can be acknowledged simply through an observance of volume. The real success of the program appears in the regeneration of teaching philosophy, methodology and enthusiasm. These in most part will show in the benefits rendered the students in the years to come.

I am not only proud to have been a part of this project, but also thank all the people involved for their cooperation. Any success or benefits of the project are theirs.

Members of this project from the Fort Benton School System will be available for consultant service to any organization or school district with regard to the outline contained herein or any other part of the project.

William J. Hoppes
Superintendent of Schools

STATEMENT OF PHILOSOPHY

We, the committee on mathematics, believe that in order to function in society today every individual must have a basic knowledge of mathematics. This becomes apparent as each of our students assumes his role as a producer and consumer in our society. As our civilization becomes more and more complex and technological advances are made, the need for even greater understanding of mathematical concepts becomes essential. Not only must a basic knowledge of mathematics be provided in a mathematics program, but also an opportunity for the gifted child to develop to the best of his ability the mathematical skills and theory demanded by the technological, as well as the scientific realms of our society.

A curriculum should provide the students with a sequential program K-12. We believe that in using a guide the teacher at each level should acknowledge the individual capabilities of the students. Each child should be allowed to experience some success in mathematics so that he will develop a confidence in his ability and a desire for continuous learning and self-improvement.

INTRODUCTION

This Mathematics Curriculum was developed primarily for the Fort Benton School System by a committee representing several Montana School Districts. The project was funded through an ESEA Title III grant to the Fort Benton Public Schools.

The writing of this curriculum outline involved a highly concentrated six-week effort on the part of each individual committeeman. The Mathematics project personnel were:

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Joseph Tacke	Chester	
Sister Elizabeth Gress	Great Falls	

TERMINOLOGY

1. ADVANCED MATHEMATICS - a course designed to provide an opportunity for the student to further his mathematical knowledge in preparation for post-secondary education.

2. ALGEBRA - a course designed to further the understanding of the basic structure of the real number system.

3. APPLICATION OF MATHEMATICS - a major theme developed in this guide that deals with the act of applying learned mathematical knowledge to one's environment.

4. BEHAVIORAL CONCEPT - refers to the major themes for each grade level written in behavioral terms.

5. BEHAVIORAL SUB-CONCEPT - refers to the more specific type of behavior expected from the student to show his understanding of the major themes.

6. BEHAVIORAL INSTRUCTIONAL OBJECTIVE - refers to those objectives developed from the behavioral concept and used to measure the terminal behavior of the student.

7. CLASSIFY - to group according to a system.

8. COMPARE - to show the contrast or similarity between things.

9. CONSTRUCT - make or finish making a drawing or construction that identifies a particular object or set of conditions.

10. CONSUMER MATHEMATICS - a course developed to offer the student mathematics which he can apply as he becomes a consumer in our society.

11. DEFINE - to establish or state clearly with authority.

12. DETERMINE - to fix conclusively or authoritatively; to come to a decision.

13. DEMONSTRATE - to explain, or show, by use of examples or other illustrative material.

14. DEVELOP - to study a concept or topic in depth.

15. DIFFERENTIATE - to recognize and state differences.

16. DISTINGUISH - to perceive as being separate or different.

17. FUNCTIONS AND RELATIONS - a major theme developed in this guide that deals with the concepts of functions and relations.

18. GENERAL MATHEMATICS - a course designed to review previously learned mathematics and apply this knowledge to practical life situations.

19. GEOMETRY - a major theme developed in this guide; a branch of mathematics that deals with the measurements, properties and relationships of figures in space.

20. IDENTIFY - to show that a thing is the same as that which is already known.

21. INDICATE - to point out or make known.

22. INTRODUCE - to present for the first time, not expecting complete development of a concept or process.

23. MANIPULATIVE OBJECTS - tangible aids used in the classroom to help develop understanding of mathematical concepts.

24. MASTER - to complete the development of a concept or topic for fullest understanding at a designated level.

25. MATHEMATICAL NOTATION - a major theme developed in this guide that deals with the symbolic representation of mathematical ideas and operations.

26. MEASUREMENT - a major theme developed in this guide that deals with the act of comparing to some unit recognized as a standard.

27. NUMBER SENTENCES - a major theme developed in this guide that deals with ideas expressed in mathematical sentences.

28. NUMBER THEORY - a major theme developed in this guide that deals with the study of numbers and the relations between them.

29. OPERATIONS - a major theme developed in this guide that deals with the process of carrying out the rules of procedures in mathematics.

30. OPTIONAL - concepts beyond the basic curriculum of a grade level, to be presented if time and ability permit.

31. PERFORM - to carry out a process; to execute.

32. RECOGNIZE - to identify or perceive to be something previously known.

33. RELATE - to give an account of an experience.

34. SHOW AN AWARENESS - to be conscious of the existence of something.

35. SIMPLIFY - the process of reducing an expression or statement to its least complex form.

36. SKETCH - to draw a rough version.

37. UNDERSTAND - to have a knowledge of; to be well-informed.

38. WORKABLE KNOWLEDGE - the ability to work with mathematical concepts and processes with understanding.

BASIC GOALS

This guide has been constructed to provide a basic sequential program and suggested options in mathematics for grades K-12 to fulfill the following goals as set forth by this committee:

1. Develop an appreciation for and an interest in the need for mathematics in daily life.
2. Develop a knowledge of mathematical concepts.
3. Develop the skill of computation.
4. Develop an understanding and use of a mathematical terminology.
5. Develop an ability to analyze and solve mathematical problems.
6. Develop the ability to apply inductive and deductive reasoning in mathematical situations.
7. Develop an ability to apply mathematical concepts and skills in daily life.
8. Develop a basis for expanded study in the field of mathematics.
9. Develop a knowledge of career opportunities in the area of mathematics.
10. Develop a desire for continuous learning and self-improvement in mathematics.

THEMES AND THEIR RATIONALE

Six themes are covered in the area of mathematics in grades K-6. The rationale for each of these themes follows:

Grade Level	Theme	Rationale
K-6	Number Theory	1. The understanding of number patterns, structure and basic properties of number systems is essential to all work in mathematics. Therefore, at an early age, the student is introduced to fundamental concepts of number theory.
	Mathematical Notation	1. Since mathematics requires a distinctive mode of communication, numerals and symbols are used to represent mathematical concepts in a symbolic form. 2. The student needs to have a functional command of this mathematical language in order to perform efficiently.
	Mathematical Operations	1. The student must develop progressively the skills needed to perform the mathematical operations accurately and efficiently. At each level of learning the student must possess a workable knowledge of these skills in order to apply them to mathematical problems.
	Geometry	1. Since we live in a three-dimensional world, the student needs to be aware of its structural design. The study of geometry gives the student a fundamental knowledge of space and geometric figures in relation to our physical world. 2. The study of geometry from K-6 will prepare the student for advanced study of this subject at higher levels.
	Measurement	1. Because of the vast use of measurement in our civilization, the study of this area of mathematics is essential to the individual so that he can function efficiently in society. 2. Because the child at an early age utilizes measurements, he needs some basic knowledge in this field. 3. The student needs to develop a background in measurement for further application at higher levels of study.
	Application of Mathematics	1. Since we live in a society involved with mathematics, the student needs to be aware of the application of mathematical knowledge to daily situations.
	Terminology	1. Because of the specific vocabulary associated with mathematics, it becomes essential that the student be able to understand and use this vocabulary in his study of this field.

In developing rationale for grades 7 and 8, the previous program has been expanded to include two additional themes.

Grade Level	Theme	Rationale
7-8	Number Sentences	1. Since the student will encounter many word sentences and word phrases, he needs to be able to express these as number sentences to perform the necessary mathematical operations. 2. Number sentences are studied at this level to prepare the student to formulate abstract ideas into concrete form as used in algebra.
	Functions and Relations	1. Functions and relations are presented to give the student a visual representation of mathematical sentences for better understanding. 2. In order to prepare the student for higher mathematics, functions and relations are introduced at this level.
9-10	General Mathematics	1. The program at these levels is designed to provide the student with a foundation for the continuing study of mathematics and, at the same time, provide the terminal student with the mathematics needed for meaningful participation in the adult community.
	Algebra I	1. Albegra develops within the student the ability to utilize abstract thinking to further the understanding of the basic structure of the real number system. 2. Albegra familiarizes the student with the varied techniques needed to work with advanced mathematics.
10	Geometry	1. Since the student lives in a geometric world, the study of geometry will help him function more efficiently in his environment. 2. Geometry will instill in the student an appreciation for, and an effective method of forming generalizations through logical thinking.
11	Algebra II	1. Albegra II provides the student with an insight into the use of mathematics in other fields of study. 2. This course provides a sound transitional basis for the continuous study of mathematics.
11 or 12	Consumer Mathematics	1. Since some students may not with to terminate their studies in mathematics with the state two-year requirement, nor wish to continue at higher levels of study, Consumer Mathematics is offered at grades 11 - 12. 2. Consumer Mathematics will offer the student mathematics that he can apply as he becomes a consumer in our society.

Grade Level	Theme	Rationale
12	Advanced Mathematics	1. This course will bring together the previous studies in mathematics and further develop them to show their application. 2. This course provides a basis for continual studies in higher mathematics beyond the secondary school.

GENERAL NOTES

1. In this curriculum guide major themes or concepts are expressed, more specific sub-concepts are listed, an example of a very specific behavioral instructional objective is indicated for each grade level and a list of resource materials is included. The format for this guide is as follows:

    Grade Level

        Behavioral Concepts - indicated by Roman numerals

            Behavioral Sub-Concepts - indicated by capital letters

                Further development of sub-concepts - indicated by Arabic numerals

    Example of Behavioral Instructional Objective.

    List of Resources - found after primary and intermediate sections and thereafter by grade level or course.

2. In this guide a code has been incorporated to indicate at which levels specific sub-concepts should be introduced (I), developed (D), mastered (M), and reviewed (R). Also included are a few optional (O) sub-concepts. These letters or a combination of these letters will appear on the left-hand side of the sub-concepts.

3. The following code is incorporated in the list of resources at the junior and senior high levels:

    NT - Number Theory - The material is concerned with mathematical concepts and ideas in number theory, number sentences, notation and operations.

    A - Application - the material shows an application of mathematics.

    G - Geometry - the material pertains to the area of geometry.

    M - Measurement - the material pertains to concepts of measurements.

4. Resources for the K-3 levels and for the 4-6 levels have been listed in groups, K-3 being primary, 4-6 being intermediate. These listings appear (K-3) at the end of the third grade program, and (4-6) at the end of the sixth grade program.

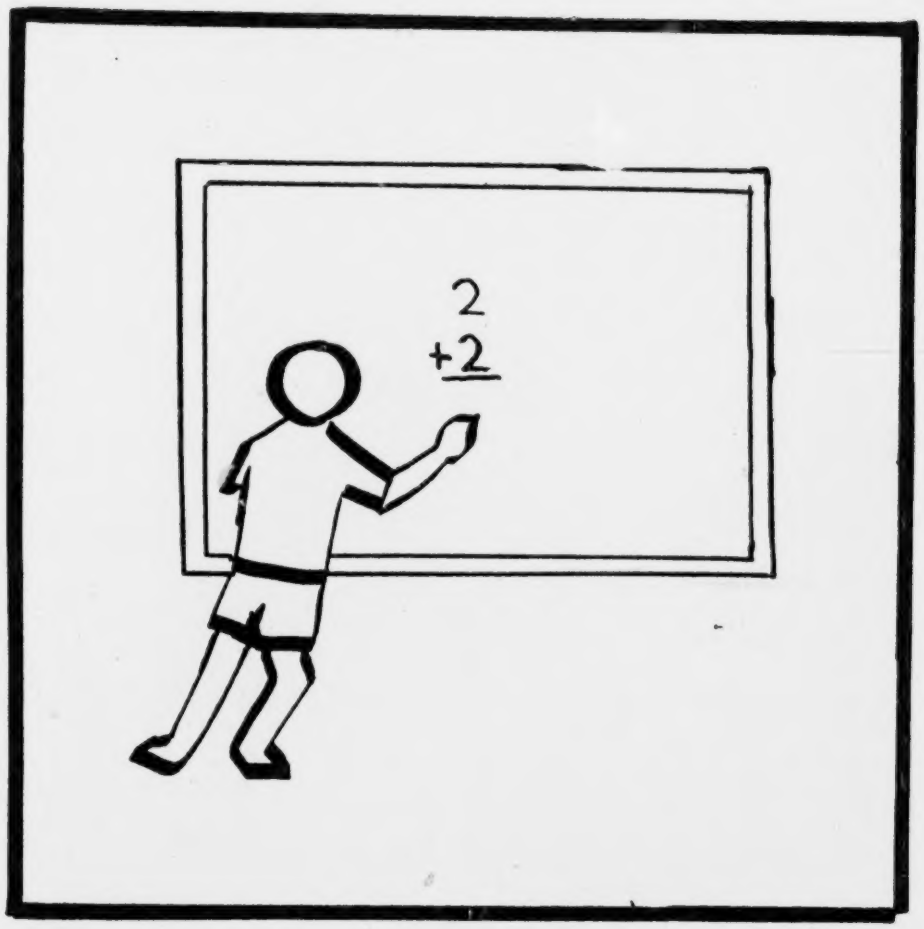
RECOMMENDATIONS

1. It is the opinion of this committee that the mathematics curriculum in the Fort Benton Schools should be expanded to include a computer programming course.

2. We also recommend that mini-courses be offered to fulfill the needs and interests of students who desire to strengthen and/or further their study in mathematics. Examples of such courses are:

   Statistics
   Refresher Mathematics
   Slide Rule
   Logic
   Non-Euclidian Geometry
   Matrix Theory
   Vectors

3. This guide is written as a basic guide and should be expanded upon by the individual teacher as the students' needs become apparent.



NUMBER THEORY MATHEMATICAL NOTATIONS AND OPERATIONS

KINDERGARTEN

I. Develop an understanding of number theory.

(M) A. The student will be able to recognize set patterns to five.
(I) B. The student will be able to compare sets for the meaning of more or less.
(I) C. The student will demonstrate, with the use of manipulative objects, an understanding of the addition process.
(I) D. The student will demonstrate, with the use of manipulative objects, an understanding of the subtraction process.
(I) E. The student will identify a number line.
(M) F. The student will identify, as a pair, two objects that belong together.
(I) G. The student will demonstrate his ability to understand ordinal numbers.

II. Develop an ability to use mathematical notation.

(M) A. The student will identify numerals to 10.
(M) B. The student will be able to write the numerals 1-10 in sequence.

III. Develop the ability to perform mathematical operations.

(M) A. The student will count in sequence to 10.
(M) B. The student will count the members of a set, matching each number name to one of the objects, i.e., one-to-one correspondence.
(M) C. The student will be able to write the numeral that corresponds to the number of members in a set.

IV. Develop an understanding of gemoetry.

(M) A. The student will identify by name a circle, a triangle, and a square.
(I) B. The student will differentiate between a square and a rectangle.

V. Develop an understanding of measurement.

(M) A. The student will identify by name a penny, a nickel, and a dime.
(I) B. The student will demonstrate how money is used as a medium of exchange.
(I) C. The student will show an awareness of the clock and time.
(M) D. The student will compare the size of objects and identify the larger and smaller items.
(M) E. The student will compare the length of objects and identify the longer and shorter items.

VI. Develop an application of mathematics.

(I) A. The student will demonstrate his ability to apply mathematical concepts to stiuations in classroom work.
(I) B. The student will relate experiences in which he has applied mathematical concepts outside the classroom.

VII. Develop an understanding and use of a mathematical terminology.

(ID) A. The student will demonstrate his ability to comprehend and use the following mathematical terms:

add	more	smaller
circle	number line	square
larger	pair	subtract
less	rectangle	triangle
longer	shorter	

Example of Behavioral Instructional Objective:

Given a set of objects or pictures with 10 or less members, the student will identify and write the numeral for the cardinal number of the set.

RESOURCES:

(All resources for this level of instruction are included in a listing which follows the example of a Behavioral Instructional Objective at the third grade level.)

GRADE ONE

I. Develop an understanding of number theory.

(M) A. The student will identify a set as a group of objects.
(I) B. The student will distinguish between members and non-members of a set.
(M) C. The student will identify a set with no members as the empty set.
(M) D. The student will compare sets of pictured objects to 10 to identify them as greater, less or equivalent.
(R) E. The student will identify as a pair two objects that belong together.
(M) F. The student will demonstrate an understanding of the addition process.
(M) G. The student will demonstrate an understanding of the subtraction process.
(ID) H. The student will demonstrate the use of the number line as applied to addition and subtraction.
(ID) I. The student will demonstrate the relationship between addition and subtraction.
(ID) J. The student will indicate an understanding of the commutative property of addition.
(ID) K. The student will identify the tens and ones places in a 2-digit numeral.
(IM) L. The student will recognize ½ in relationship to a whole.
(I) M. The student will recognize ¼ in relationship to a whole.
(IM) N. The student will identify ½ of a set of objects.

II. Develop an ability to use mathematical notation.

(M) A. The student will recognize, name and write numerals 0-100.
(IM) B. The student will read number words through ten.
(M) C. The student will identify the position of an object, using ordinal numbers first through tenth.
(IM) D. The student will demonstrate his ability to use the addition (+), subtraction (-), and equal (=) signs.
(ID) E. The student will demonstrate his ability to use "greater than" (>) and "less than" (<) signs.
(ID) F. The student will demonstrate his ability to write 2-digit numerals in expanded form.
(ID) G. The student will write 2-digit expanded numerals in standard form.
(IM) H. The student will arrange addition and subtraction problems in either horizontal or vertical form.

III. Develop the ability to perform mathematical operations.

(M) A. The student will name and write the sums of addition combinations through 10.
(M) B. The student will name and write the differences of subtraction combinations through 10.
(IM) C. The student will add three addends with a sum of 10 or less.
(ID) D. The student will add 2-digit numerals without regrouping.
(ID) E. The student will subtract 2-digit numerals without regrouping.
(ID) F. The student will demonstrate his ability to find a missing addend in a mathematical sentence with a sum of ten or less.
(ID) G. The student will compare numbers to 100 using the "greater than" (>) and "less than" (<) signs.
(IM) H. The student will count by 10's to 100.
(IM) I. The student will count by 5's to 100.
(IM) J. The student will count by 2's to 20.

IV. Develop an understanding of geometry.

(M) A. The student will identify and name a circle, triangle, square, and rectangle.
(I) B. The student will compare a square to a cube, a triangle to a pyramid, and a circle to a sphere.

V. Develop an understanding of measurement.

(IM) A. The student will be able to tell time on the hour.
(I) B. The student will tell time on the half-hour.
(ID) C. The student will demonstrate his ability to read the calendar.
(M) D. The student will demonstrate how money is used as a medium of exchange.
(M) E. The student will identify the value of the penny, nickel, and dime.
(I) F. The student will identify the quarter and its value.
(ID) G. The student will determine the value of combinations of coins.
(R) H. The student will compare lengths of objects for longer and shorter.
(I) I. The student will use a straight-edge for drawing lines.
(I) J. The student will use a ruler to measure objects to the nearest inch.
(M) K. The student will identify scales as a means of measuring weight.

VI. Develop an application of mathematics.

(M) A. The student will listen to or read a story problem and give a sum or difference.
(D) B. The student will demonstrate his ability to apply mathematical concepts and operations in daily situations.
(ID) C. The student will listen to or read story problems and write a relative equation.

VII. Develop an understanding and use of a mathematical terminology.

(ID) A. The student will demonstrate his ability to add to his previous vocabulary the following mathematical terms:

addend	less than	plus
equal	minus	ruler
equivalent	number	sets
expanded	number sentence	sum
greater than	numeral	tens
inch	ones	

Example of Behavioral Instructional Objective:

Given a 2-digit numeral, the student will identify and write the numerals that are in the ones and tens place.

RESOURCES:

(All resources for this level of instruction are included in a listing which follows the Example of a Behavioral Instructional Objective at the third grade level.)

GRADE TWO

I. Develop an understanding of number theory.

(M) A. The student will compare any two numbers from 0-999 for their "greater than" or "less than" value.
(M) B. The student will demonstrate the relationship between addition and subtraction.
(ID) C. The student will identify even and odd numbers.
(M) D. The student will recognize 1/2, 1/4, 1/3 in relationship to a whole.
(M) E. The student will identify 1/3 and 1/4 of a set of objects.
(M) F. The student will identify the hundreds, tens and ones places in a 3-digit numeral.
(D) G. The student will indicate an understanding of the commutative property of addition.
(I) H. The student will indicate an understanding of the associative property of addition.
(I) I. The student will show an awareness of division as the partitioning of a set into equivalent sub-sets.
(I) J. The student will show an awareness of multiplication as the joining of equivalent sets.

II. Develop an ability to use mathematical notation.

(M) A. The student will read and write any numeral from 0-999.
(D) B. The student will demonstrate his ability to use "greater than" (>) and "less than" (<) signs.
(ID) C. The student will write 3-digit expanded numerals in standard form.
(ID) D. The student will write 3-digit numerals in expanded form.
(M) E. The student will read and write 1/2, 1/3, 1/4.

III. Develop the ability to perform mathematical operations.

(IM) A. The student will name and write the sums of addition combinations through 20.
(IM) B. The student will name and write the differences of subtraction combinations through 20.
(M) C. The student will add two or three 2-digit numerals without regrouping.
(M) D. The student will subtract 2-digit numerals without regrouping.
(ID) E. The student will add two 2-digit numerals with regrouping.
(ID) F. The student will subtract 2-digit numerals with regrouping.
(M) G. The student will add four 1-digit numerals.
(M) H. The student will compare numers to 999 using the "greater than" and "less than" signs.
(I) I. The student will join equivalent sets in preparation for multiplication.
(I) J. The student will name a missing factor in a multiplication sentence as a readiness for division.
(M) K. The student will write by 10's to 100.
(M) L. The student will write by 5's to 100.
(M) M. The student will write by 2's to 100.

IV. Develop an understanding of geometry.

(D) A. The student will compare a square to a cube, a triangle to a pyramid, and a circle to a sphere.
(ID) B. The student will identify a line segment.
(I) C. The student will identify the number of sides, corners, and square corners in a geometric plane figure.

V. Develop an understanding of measurement.

(DM) A. The student will be able to tell time on the half-hour.
(ID) B. The student will tell time on the quarter hour.
(M) C. The student will demonstrate his ability to read the calendar.
(M) D. The student will identify the quarter and its value.
(ID) E. The student will identify the half-dollar and dollar and their value.
(D) F. The student will determine the value of combined coins.
(M) G. The student will measure to the nearest inch.
(ID) H. The student will measure to the nearest half-inch.
(ID) I. The student will measure to the nearest foot.
(I) J. The student will realize that 12 inches = 1 foot.
(I) K. The student will identify cup, pint, quart, and gallon containers and compare the amounts of liquid they hold.
(M) L. The student will identify pounds and ounces as units of weight measurement.
(M) M. The student will identify a set of 12 as a dozen and a set of 6 as a half-dozen.

VI. Develop an application of mathematics.

(M) A. The student will listen to or read a story problem and give a sum or difference.
(D) B. The student will listen to or read a story problem and write a related equation.
(D) C. The student will demonstrate his ability to apply mathematical concepts and operations in daily situations.

VII. Develop an understanding and use of a mathematical terminology.

(ID) A. The student will demonstrate his ability to add to add to his previous terminology the following mathematical terms:

addition	gallon	pint
corner	half-dozen	pound
cup	hundreds	quart
divide	line segment	regrouping
dozen	multiply	renaming
equation	odd numbers	square corner
even numbers	ounce	subtraction
foot		

Example of a Behavioral Instructional Objective:

The student will write the sums of the one hundred addition combinations in five minutes with 95% accuracy.

RESOURCES:

(All resources for this level of instruction are included in a listing which follows the Example of a Behavioral Instructional Objective at the third grade level.)

GRADE THREE

I. Develop an understanding of number theory.

(M) A. The student will identify even and odd numbers.
(D) B. The student will indicate an understanding of the commutative property of addition.
(M) C. The student will identify place value in a 4-digit numeral.
(M) D. The student will compare any two numbers from 0-9999 for their "greater than" and "less than" value.
(IM) E. The student will recognize 1/5, 1/6, 1/8 in relationship to a whole.
(I) F. The student will compare any two fractions with numerators of 1 for "greater than" or "less than" value.
(I) G. The student will recognize that a fraction is equal to 1 if the numerator and the denominator are the same.
(M) H. The student will demonstrate his understanding of multiplication as a joining of equivalent sets.
(M) I. The student will demonstrate his understanding of division as the partitioning of a set into equivalent subsets.
(ID) J. The student will indicate an understanding of the commutative property of multiplication.
(ID) K. The student will demonstrate his understanding of the associative property in addition and multiplication.
(M) L. The student will demonstrate his understanding of multiplying and dividing by one and zero.
(ID) M. The student will show an awareness of the distributive property of multiplication over addition.

II. Develop an ability to use mathematical notation.

(IM) A. The student will read and write any 5-digit numeral.
(IM) B. The student will write 4-digit numerals in expanded form.
(IM) C. The student will write 4-digit expanded numerals in standard form.
(IM) D. The student will read and write the fractions 1/5, 1/6, 1/8.
(IM) E. The student will recognize and write the dollar ($) and cent (¢) signs and the location of the decimal point in money notation.
(IM) F. The student will identify and use the multiplication (x) and division (÷) (⌐) signs.

III. Develop the ability to perform mathematical operations.

(M) A. The student will add two 4-digit numerals without regrouping.
(IM) B. The student will add five 1-digit numerals.
(D) C. The student will add up to and including three 4-digit numerals with regrouping.
(M) D. The student will subtract 4-digit numerals without regrouping.
(D) E. The student will subtract 4-digit numerals with regrouping.
(IM) F. The student will name and write the products of multiplication combinations through five times ten.
(ID) G. The student will name and write the products of multiplication combinations through ten times ten.
(IM) H. The student will name and write the quotient of division combinations with divisors less than or equal to 5 and dividends less than or equal to 50.
(ID) I. The student will name and write the quotient of division combinations with divisors less than or equal to 9, dividends less than or equal to 81 and remainders of 0.

(ID) J. The student will multiply up to 3-digit numerals by a 1-digit numeral.
(ID) K. The student will divide up to 3-digit numerals by a 1-digit numeral.
(ID) L. The student will round off numbers to the nearest tens and hundreds.

IV. Develop an understanding of geometry.

(M) A. The student will identify a line segment.
(I) B. The student will identify a right angle.
(I) C. The student will identify parallel lines.
(I) D. The student will show an awareness of symmetry.
(I) E. The student will identify the radius, diameter, and center of a circle.

V. Develop an understanding of measurement.

(M) A. The student will be able to tell time on the quarter hour.
(ID) B. The student will be able to tell time on the minute.
(M) C. The student will identify the value of all coins.
(D) D. The student will determine the value of combined coins.
(M) E. The student will measure to the nearest inch, half-inch, and foot.
(I) F. The student will measure to the nearest quarter-inch and yard.
(I) G. The student will show an awareness of centimeters as a unit of measure.
(I) H. The student will identify perimeter as the distance around a plane polygonal figure.
(M) I. The student will realize that 12 inches = 1 foot.
(IM) J. The student will realize that 3 feet = 1 yard and that 36 inches = 1 yard.
(M) K. The student will identify cup, pint, quart, and gallon containers and compare the amounts of liquid they hold.
(IM) L. The student will realize that 16 ounces = 1 pound.

VI. Develop an application of mathematics.

(D) A. The student will listen to or read a story problem and write a related addition, subtraction, multiplication or division equation.
(D) B. The student will demonstrate his ability to apply mathematical concepts and operations in daily situations.

VII. Develop an understanding and use of a mathematical terminology.

(ID) A. The student will demonstrate his ability to add to his previous vocabulary the following mathematical terms:

array	digit	radius
associative property	division	rounding numbers
center of circle	expanded form	standard numeral
centimeter	fractions	symmetry
commutative property	multiplication	ten thousands
decimal point	parallel lines	thousands
diameter	perimeter	yards

Example of a Behavioral Instructional Objective:

Given a pictured set of all United States coins, the student will identify each coin by name and write its value.

RESOURCES:

(All resources for grades K-3 are included in the listing which follows.)

RESOURCES FOR THE PRIMARY DEPARTMENT (K-3):

Books:

Text: Exploring Elementary Mathematics - Holt, Rinehart & Winston, 1970 (1,2,3)

Curriculum Library Sample Texts:

Discovery Mathematics - Charles E. Merrill, 1970 (1,2,3)
Essential Modern Mathematics - Ginn & Company, 1970 (2,3)
Laidlaw Brothers - 1970 series (1,2,3)
Modern Mathematics - Charles E. Merrill, 1970 (2,3)
Modern Mathematics Through Discovery - Silver Burdett, 1970 (1,2,3)
Modern School Mathematics - Houghton Mifflin, 1970 (1,2,3)
New Dimensions in Mathematics - Harper and Row, 1970 (1,2,3)
New Steps in Mathematics - American Book Co., 1969 (2,3)
Spectrum Mathematics Series - Red Book, 1970 (3)

Other References:

Mathematics Seatwork for Primary Grades - Chappel, Bernice (worksheets,(K-3)
Building Arithmatic Skills with Games - Corle, Clyde G. (K-3)
Arithmatic Games - Dumas, Enoch (K-3)
Introducing Children to Mathematics - Lawson, Ernestine M. (K-3)
King Pancho and the First Clock - Lopez, Norbert C. (K-3)
Modern Math Games, Activities and Puzzles - Thomason, Mary E. (K-3)

Central Library:

All Kinds of Time - Behn, Harry, 529 Beh (K-1)
Take a Number (games & puzzles) - Bendick, Jeanne, 511 Ben (1,2,3)
Money Makes Sense (worksheets) - Kahn, Charles H., 511 Kah (1,2,3)
Education of T. C. Mits - Lieber, Lillian I., 510 Lie
Mathematics, First Steps - Lieber, Lillian I., 511 Lie (3)
The Day the Number Disappeared - Simon, Leonard, 511 Sim (3)
Inquisitive Games - Sprigle, Herbert A., 511 Spr
Math Awareness - Trivett, John V., 511 Tri
A Book to Begin on Numbers - Waller, Leslie, 511 W (1,2,3)
Let's Find About Subtraction - Whitney, David C., 511 W (1,2,3)
Brian Wildsmith's 1,2,3's - Wildsmith, Brian, 511 Wil (K-1)

Filmstrips:

Arithmatic Experiences for the Third Year 511

Arithmetic Experiences for the Third Year #1 (multiplication) (3)
Arithmetic Experiences for the Third Year #2 (general) (3)
Arithmetic Experiences for the Third Year #3 (thermometer & money) (2,3)
Arithmetic Experiences With Measurement #4 (measurement) (2,3)
Arithmetic Experiences With More Measurement #5 (measurement) (1,2,3)
Arithmetic Experiences With Time #6 (time) (2,3)
Arithmetic Experience With Comparisons #7 (comparisons) (K-1)
Arithmetic Experience: The Game of How Many #8 (K-1)

Using Modern Mathematics 511 USI

Understanding the Structure of Numbers (study tens and ones) (1,2)
Using and Understanding two and three place numbers (2,3

Adding and Subtracting and Measure (fractions 1/2, 1/3, 1/4; pint; quart; pounds; ounces) (3)
Adding and Subtracting Two and Three Place Numbers (introduces commutative property) (2,3)
New Phases of Addition and Subtraction (with zero) (2,3)
Multiplying and Dividing (a review) (3)
Advancing Addition, Subtraction, and Division (with regrouping) (3)

Work and Play With More Problems, 511 Brid (1)

Bridging the Decades With 11, 511 Brid (2)
Bridging the Decades With 12 & 13, 511 Brid (2)
Bridging the Decades With 14 & 15, 511 Brid (2)
Bridging the Decades With 16 & 17, 511 Brid (2)
Bridging the Decades With 18, 511 Brid (2)
Bridging the Decades With 19, 511 Brid (2)
Bridging the Decades With 20, 511 Brid (2)

Work and Play With Problems, 511 Brid (3)
Compound Subtraction (regrouping), 511 Com (3)
Names for Numbers, 511 Mat (2)
Two Properties of Addition, 511 Mat (3)
Numbers in Color (Cuisénaine Rods), 511 Num (K-3)
What Numbers Mean, 511 Wha (K)
The Threes (multiplication), 511 Thr (3)
Twos in Division, 511d Two (3)
Fractional Parts of the Whole, 511s Frac (3)
Comparing Fractions, 511 w Comp (2,3)
Fractional Parts of Groups, 511t Frac (1,2)
Two Properties of Multiplication: Commutative & Associative, 511 (3)

8 mm Filmloops:

One-to-One, 510 (1,2,3)
Inequalities, 510 (=, > , <) (1,2,3)
Flow Charts, 510 (1,2,3)

Records:

Learning the ABC's and How to Count, 411 (K-1)
Addition Made Easy, 511 (1)
Ten Little Indians (511 ten (K-1)
Multiplication, 511 (3)

Charts:

Place-value Chart, 511 (2,3)
Combination Boards, 511 (3)

Transparencies:

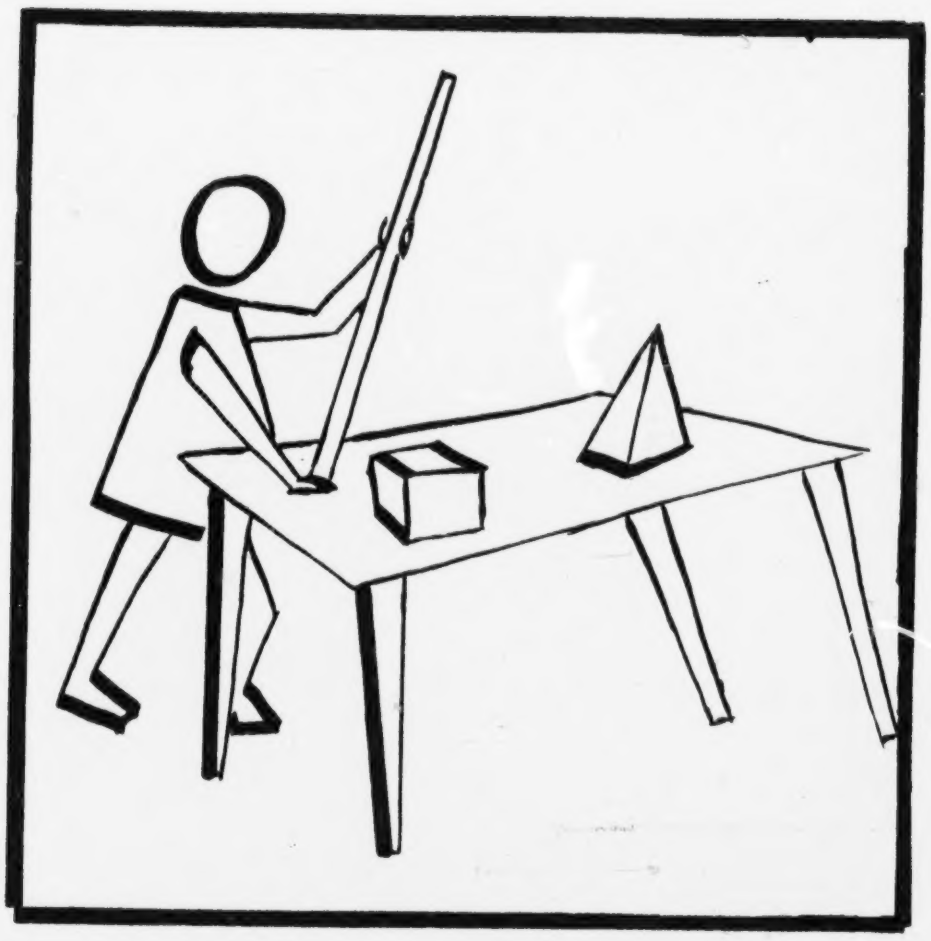
Clock, 529 (1,2,3)
Associative Property, 511 (3)
Commutative Property, 511 (2,3)
Concept of Sets, 511 (K-1)
Counting by 1's, 2's, 5's, 10's, 511 (1-2)
Discovering Sets, 511 (K-1)

Equalities and Inequalities, 511 (1,2,3)
Equivalent and Non-equivalent Sets, 511 (1)
Zero and Empty Sets, 511 (1)
Number System, Place Value (whole numbers), 511 (2,3)

Games, Kits, Models: 511

Smarty (2,3)
Cross Number Puzzles: #1 & 2 Addition Sets (1,2)
#1 & 2 Advanced Addition Sets (2,3)
Dial the Facts: addition (2,3)
subtraction (2,3)
multiplication (3)
division (3)
Orbiting the Earth (division & multiplication) (3)
Table Timer (1-3)
Self (2,3)
Quizmo (2,3)
Numberland Special (2,3)
Cuisenaire Classroom Kit Notes, 511 Cuis (K-3)
Cuisenaire Exploration Sheets, 511 Gall (K-3)
Cuisenaire Rods - Gattegno, C., 511 Gatt (K-3)
Manuals A. B. C. D for Cuisenaire Rods, 511 Gott (K-3)
Cuisenaire Rods (K-3)
Geometric Figures, 511 Geo (3)
Fraction Discs, 511 Frac (1-3)
Rapid Easy Self-Drill Charts (A,S,M), 511 (1,2,3)
Play Money, 332.4 (K-3)
Instrocto Flannel Board Materials, 511: Number Line (K-3)
Numbers (K-3)
Reading Whole Numbers (1-3)
Primary Cut-outs (K-3)
Vocabulary and Symbols (1-3)

Felt Numerals (K-3)
Mathematical Balance, 511 (K-3)
Abacus, (K-3)



GEOMETRY MEASUREMENTS

GRADE FOUR

I. Develop an understanding of number theory.

A. The student will develop an understanding of sets.

(R) 1. The student will be able to distinguish between members and non-members of a set.

(IM) 2. The student will be able to identify three dots as a symbol for the continuation of the members of a set as used in infinite sets.

(R) 3. The student will be able to distinguish between equivalent and non-equivalent sets.

(ID) 4. The student will be able to demonstrate his understanding of subsets.

B. The student will develop an understanding of whole numbers.

(D) 1. The student will be able to determine the cardinal numbers of a set.

(D) 2. The student will be able to distinguish between ordinal and cardinal numbers.

(D) 3. The student will be able to classify even and odd numbers.

(M) 4. The student will be able to name the place value of a digit through the thousands place.

(R) 5. The student will be able to identify the "less than" and "greater than" relationships.

(IM) 6. The student will be able to demonstrate an understanding of successive numbers.

(D) 7. The student will be able to demonstrate an understanding of the commutative and associative properties of addition and multiplication.

(D) 8. The student will be able to recognize the distributive property of multiplication over addition.

C. The student will develop an understanding of rational numbers.

(D) 1. The student will be able to identify parts of a whole from a given model.

(ID) 2. The student will be able to identify numerators and denominators.

(ID) 3. The student will be able to demonstrate the relationships of equivalent fractions with a given set of objects.

(ID) 4. The student will be able to compare two fractions for their "less than" or "greater than" values using models.

(I) 5. The student will be able to identify fractional parts on a number line.

II. Develop an ability to use mathematical notation.

A. The student will develop an understanding of names for numbers.

(D) 1. The student will be able to identify, read and write many different names for the same number ($12 = 7 + 5$; $27 - 15 = 12$; $3 \times 4 = 12$; $48 \div 4 = 12$; $11 + \frac{1}{2} + \frac{1}{2} = 12$).

(IM) 2. The student will be able to identify, read and write Roman numerals through ten.

B. The student will develop the ability to use the notation of whole numbers.

(M) 1. The student will be able to identify, read and write numerals to one million.

(M) 2. The student will be able to write word names for a given numeral to one million.

(ID) 3. The student will be able to identify and name the place value of each digit of a 6-digit numeral.

(ID) 4. The student will be able to write in expanded form numerals to one million.

C. The student will develop the ability to use the notation of positive rational numbers.

(ID) 1. The student will be able to identify, name, read and write a fractional numeral for the rational number associated with a model.

(ID) 2. The student will be able to read and write the numerator and denominator of a given fraction.

(ID) 3. The student will be able to write a set of simple equivalent fractions for a given fraction with the use of a model (e.g., 1/2 = 2/4).

(I) 4. The student will be able to compare an improper fraction with a mixed numeral using a model.

(I) 5. The student will be able to read and write a mixed numeral represented by a model.

III. Develop the ability to perform mathematical operations.

A. The student will develop the ability to use the mathematical operations of whole numbers.

(D) 1. The student will be able to solve addition and subtraction equations of 2, 3, and 4-digit numbers using inverse relationships.

(M) 2. The student will be able to subtract by regrouping through the thousands place.

(R) 3. The student will be able to add and subtract both vertically and horizontally.

(R) 4. The student will be able to use the zero in addition as the identity element.

(D) 5. The student will be able to apply the commutative and associative properties in column addition up to six addends.

(M) 6. The student will be able to solve simple multiplication equations with 2-digit multipliers.

(M) 7. The student will be able to divide by a 1-digit divisor with a remainder.

(ID) 8. The student will be able to divide by a 2-digit divisor with or without a remainder.

(M) 9. The student will be able to name or write the multiplication combinations through 10 x 10.

(D) 10. The student will be able to demonstrate a knowledge of the distributive property of multiplication over addition.

(R) 11. The student will be able to demonstrate a knowledge of the zero property in multiplication.

(R) 12. The student will be able to demonstrate a knowledge of the identity element (1).

(M) 13. The student will name and write the quotient of division combinations with divisors less than or equal to nine and dividends less than or equal to 81 with remainders of 0.

B. The student will develop the ability to use the mathematical operations of rational numbers.

(M) 1. The student will be able to add and subtract problems concerning dollars and cents (decimal notation).

(O) 2. The student will be able to add and subtract two rational numbers with like denominators.

C. The student will develop an understanding of rounding off numbers.

(M) 1. The student will be able to round off numbers through the thousands place.

IV. Develop an understanding of Gemoetry.

A. The student will develop an understanding of geometric figures.

1. The student will be able to rc . e and identify the following plane figures:
   - (D) point
   - (D) line
   - (D) line segment
   - (ID) ray
   - (I) curve (path)
2. (D) The student will be able to recognize and identify a right angle.
3. The student will be able to recognize and identify through their properties the following polygons:
   - (D) triangle
   - quadrilateral:
     - (D) square
     - (D) rectangle
     - (I) parallelogram
4. The student will be able to recognize and identify the following parts of a circle:
   - (D) center
   - (D) radius
   - (D) diameter
   - (I) chord
5. The student will be able to recognize and identify the following space figures:
   - (I) sphere
   - (I) cube
   - (I) cylinder
   - (I) cone
   - (I) pyramid

B. The student will develop an understanding of geometric properties.
1. The student will be able to sketch and describe the following:
   - (D) parallel lines
   - (I) intersecting lines
   - (I) simple closed curve
   - (ID) perimeter of a polygon
2. (ID) The student will be able to determine and name the perimeter of a given model polygon with the use of a ruler.
3. (I) The student will be able to compute area of a square or rectangle with the use of a model.
4. (O) The student will be able to compute volume of a cube with the use of a simple model.

C. The student will develop the ability to construct geometric figures.
1. (ID) The student will be able to identify and use a protractor, a compass, and a straightedge.
2. The student will be able to construct and label the following:
   - (I) line
   - (I) line segment
   - (I) ray
   - (I) angle
   - (I) quadrilateral
   - (I) triangle
   - (I) right triangle (using folded paper)
   - (I) circle (given a center and radius)

V. Develop an understanding of Measurement.

A. The student will develop an understanding of concepts of measurement.

(ID) 1. The student will be able to select the proper unit of measurement (length, area, weight, temperature).
(ID) 2. The student will be able to express the measurement of a physical object in two units.
(I) 3. The student will be able to show knowledge of the idea of precision and approximation.

B. The student will develop an understanding of the measure of physical properties.

(D) 1. The student will be able to select the proper device (ruler, yardstick, meterstick) to measure the following: inch, foot, yard, mile, centimeter, meter.
(ID) 2. The student will be able to convert one standard English unit of liquid measure to another (ounce, cup, pint, quart, gallon).
(M) 3. The student will be able to express time to the nearest minute.
(ID) 4. The student will be able to express time in terms of a.m. and p.m.
(ID) 5. The student will be able to measure the weight of a given object in whole and fractional part using a scale (ounce, pound, ton).
(ID) 6. The student will be able to read and write temperature with the use of a thermometer to the nearest degree of Fahrenheit and Centigrade.
(ID) 7. The student will be able to make change up to and including one dollar.

C. The student will develop an understanding of renaming units of measure.

1. The student will be able to convert and compare the following:

(I) meter-yard
(I) pounds-ton
(I) inches-feet
(I) feet-yard
(I) inches-yard
(I) feet-mile
(I) inches-centimeters
(I) kilograms-grams
(I) cups-pints
(I) pints-quarts
(I) quarts-gallon
(I) hours-minutes
(I) ounces-pounds

VI. Develop an application of mathematics.

(D) A. The student will be able to listen to or read a story problem and give a sum, difference, quotient or product.
(D) B. The student will be able to listen to or read a story problem and write a related equation.
(D) C. The student will be able to demonstrate his ability to apply mathematical concepts and operations in daily situations.

VII. Develop an understanding and use of a mathematical terminology.

(ID) A. The student will demonstrate his ability to add to his previous vocabulary the following mathematical terms:

angle	intersect	perpendicular lines
area	intersecting lines	quadrilateral
counting numbers	isosceles triangle	ray
cube	length	related sentence
difference	metric system	right angle
empty set	multiple	vertex
equilateral triangle		whole numbers

B. The student will be able to demonstrate his ability to use the following mathematical symbols:

(ID) angle A ($\angle A$)
(ID) degrees (m^{o})
(ID) line segment from point A to point B ($\overline{AB}$)
(ID) line through points A and B ($\overleftrightarrow{AB}$)
(ID) ray from A through B ($\overrightarrow{AB}$)

Example of a Behavioral Instructional Objective:

Given ten multiplication equations with 2-digit multipliers and 3-digit multiplicands, the student will solve the equations within thirty minutes with at least 87% accuracy.

RESOURCES:

(All resources for this level of instruction are included in a listing which follows the Example of a Behavioral Instructional Objective at the sixth grade level.)

GRADE FIVE

I. Develop an understanding of number theory.

A. The student will develop an understanding of sets.

(ID) 1. The student will be able to demonstrate the relationship between sets through the use of the Venn diagram.

(D) 2. The student will be able to classify sets as finite, infinite and empty.

B. The student will develop an understanding of whole numbers.

(R) 1. The student will be able to determine the cardinal number of a set.

(M) 2. The student will be able to name the place value of each digit through the millions.

(ID) 3. The student will be able to distinguish between prime and composite numbers.

(ID) 4. The student will be able to name the multiples of a given number.

(D) 5. The student will be able to recognize a common element (intersection) in two or more sets.

(D) 6. The student will be able to demonstrate his understanding of the commutative and associative properties of addition and multiplication.

(D) 7. The student will be able to demonstrate his understanding of the distributive property of multiplication over addition.

C. The student will develop an understanding of rational numbers.

(ID) 1. The student will be able to recognize that a fraction expresses the ratio between two whole numbers.

(D) 2. The student will be able to compare two fractions for their "less than" and "greater than" value.

(I) 3. The student will be able to understand the relationship between decimal fractions and money notations.

(ID) 4. The student will be able to demonstrate his understanding that a rational number can represent a ratio, a fraction, or a comparison.

(O) 5. The student will be able to identify a reciprocal of a given fraction.

II. Develop the ability to use mathematical notation.

A. The student will develop an understanding for names for numbers.

(ID) 1. The student will be able to identify, name, read and write many different names for the same number (i.e., six and seven tenths - 6-7/10, 6 + 7/10, 6.7, 67/10, 2 + 4 + .7).

(M) 2. The student will be able to identify, read and write Roman numerals through hundreds.

B. The student will develop the ability to use the notation of whole numbers.

(M) 1. The student will be able to identify, read and write numerals to one million.

(M) 2. The student will be able to write word names for a given numeral to one million.

(ID) 3. The student will be able to identify and name the place value of each digit in a 9-digit numeral.

(ID) 4. The student will be able to write in expanded form the numerals to one billion.

(ID) 5. The student will be able to identify, read and write the word names for the period value of numbers.

(ID) 6. The student will be able to write the prime factors of a given composite number.

C. The student will develop the ability to use the notation of integers.

(I) 1. The student will be able to associate opposite points on a number line.

III. Develop an ability to perform mathematical operations.

A. The student will develop the ability to use the mathematical operations for whole numbers.

(M) 1. The student will be able to solve addition and subtraction equations of two, three, and four digit numbers using the inverse relationship.
(M) 2. The student will be able to solve addition and subtraction problems containing a zero.
(R) 3. The student will be able to add and subtract both horizontally and vertically.
(M) 4. The student will be able to solve multiplication equations of three digit multipliers.
(M) 5. The student will be able to divide by a 2-digit divisor with or without a remainder.
(ID) 6. The student will be able to solve problems by "short division" method.
(ID) 7. The student will be able to divide by a 3-digit divisor with or without remainders.
(ID) 8. The student will be able to compute averages.
(ID) 9. The student will be able to find the greatest common factor of two multiples.
(ID) 10. The student will be able to find the least common multiple of two factors.
(D) 11. The student will be able to demonstrate the distributive property of multiplication over addition from a given multiplication problem.
(D) 12. The student will be able to demonstrate the use of the zero property in multiplication.
(D) 13. The student will be able to demonstrate the use of the identity element (one) for multiplication.
(D) 14. The student will be able to demonstrate the use of the identity element (one) for addition.

B. The student will develop the ability to use the mathematical operation for rational numbers.

(M) 1. The student will be able to add and subtract proper fractions with like denominators.
(ID) 2. The student will be able to add and subtract proper fractions with unlike denominators.
(ID) 3. The student will be able to multiply simple fractions.
(ID) 4. The student will be able to demonstrate an understanding of the associative, commutative and identity properties of addition in rational numbers.

C. The student will develop an understanding of rounding numbers to a given place.

(M) 1. The student will be able to round off numbers through the millions place.
(M) 2. The student will be able to estimate products to the nearest thousand, ten thousand, and one hundred thousand.

IV. Develop an understanding of Geometry.

A. The student will develop an understanding of geometric figures.

1. The student will be able to recognize and identify the following plane figures and their symbols:

(M) point
(M) curve
(M) line
(M) line segment
(M) ray

2. The student will be able to recognize and identify the parts of an angle:
(ID) vertex
(ID) ray
3. The student will be able to identify and describe the following polygons:
(M) triangle
quadrilateral:
(M) parallelogram
(M) square
(M) rectangle
(M) rhombus
(ID) pentagon
(ID) hexagon
(ID) octogon
4. The student will be able to recognize and identify the following parts of a circle:
(M) chord
(M) diameter
(M) radius
(M) center
(ID) circumference
5. The student will be able to recognize and identify the following space figures:
(ID) cube (rectangular prism)
(ID) sphere
(ID) cylinder
(ID) cone
(ID) pyramid
(ID) hemisphere

B. The student will develop an understanding of geometric properties.
1. The student will be able to sketch and describe the following:
(M) parallel lines
(D) intersecting lines
(D) simple closed curve
(D) perimeter
(ID) perpendicular lines
(D) 2. The student will be able to determine and name the perimeter of a given model polygon with the use of a ruler.
(D) 3. The student will be able to determine area with the use of a model.
(ID) 4. The student will be able to compute volume with the use of a simple model.
5. The student will be able to determine congruency with use of models:
(ID) line segments
(ID) angles
(ID) triangles
(ID) polygons

C. The student will develop the ability to construct geometric figures.
(D) 1. The student will be able to identify and use a protractor, a compass, and a straightedge.
2. The student will be able to construct and label with symbols, the following:
(D) line
(D) line segment
(D) ray
(D) angles
(D) quadrilaterals
(D) triangles
(D) other polygons
(D) circle (given the radius or diameter)

(ID) 3. The student will be able to construct simple congruent figures.
(ID) 4. The student will be able to bisect a line and the angles of a triangle using a compass and a straightedge.
(ID) 5. The student will be able to construct a simple geometric design using a compass.

V. Develop an understanding of Measurement.

A. The student will develop an understanding of measurement concepts.
(D) 1. The student will be able to select the proper unit of measurement (e.g., length, area, weight, temperature, etc.).
(D) 2. The student will be able to express the measurement of a physical object in two or more units.
(D) 3. The student will be able to demonstrate with the use of an instrument the idea of precision and approximation.

B. The student will develop an understanding of the measurement of physical properties.
1. The student will be able to select the proper device for measuring the following:
(ID) millimeter
(R) inch
(R) foot
(R) yard
(R) mile
(R) centimeter
(R) meter
2. The student will be able to convert one standard unit of liquid measure to another:
(ID) liter
(D) ounce
(D) cup
(D) pint
(D) quart
(D) gallon
(ID) 3. The student will be able to express time using the second, the minute, the hour, the year, the decade, the century, the time zones.
(ID) 4. The student will be able to express the units of weight, in ounces, in pounds, in tons, or in grams.
(O) 5. The student will be able to express temperature to the nearest degree and name the freezing and boiling points in Fahrenheit and Centigrade.
(D) 6. The student will be able to make change up to and including five dollars.

C. The student will develop an understanding of renaming units of measure.
1. The student will be able to convert and compare the following:
(R) meter-yard
(R) pounds-tons
(R) inches-feet
(R) feet-yards
(R) inches-yards
(R) feet-miles
(R) inches-centimeters
(R) kilogram-gram
(R) cup-pint
(R) pint-quart
(R) quart-gallon
(R) hours-minutes
(R) ounces-pounds
(ID) 2. The student will be able to convert square inches to square feet.

VI. Develop an application of mathematics.

(D) A. The student will be able to listen to or read a story problem and give a sum, difference, quotient or product.

(D) B. The student will be able to listen to or read a story problem and write a related quotient.

(D) C. The student will be able to demonstrate his ability to apply mathematical concepts and operations in daily situations.

VII. Develop an understanding and use of a mathematical terminology.

(ID) A. The student will be able to demonstrate his ability to add to his previous vocabulary the following mathematical terms:

acute angle
circumference
common factor
common
multiple
composite number
congruent
denominator
diagonal
dimensions
dividend
divisor
equivalent decimals
equivalent fractional numerals
estimating
exponents
factorization
finite set
graph
greatest common factor
inequality
infinite set
integers
least common denominator
least common multiple
mixed numeral
open number sentence
natural number
numerator
parallelogram
prime number
protractor
rate
ratio
region
replacement set
rhombus
solution
sphere
trapezoid
unit
Venn diagram
volume

B. The student will be able to demonstrate his ability to add to his previous knowledge the following mathematical symbols:

(ID) angle ($\angle ABC$)
(ID) celsius (C^{o})
(ID) ten expressed to the fourth power (10^{4})
(ID) Fahrenheit (F^{o})

Example of a Behavioral Instructional Objective:

Given a set of numbers from 5-20, the student will list the prime numbers and the composite numbers in identified columns.

RESOURCES:

(All resources for this level of instruction are included in a listing which follows the Example of a Behavioral Instructional Objective at the sixth grade level.)

GRADE SIX

I. Develop an understanding of number theory.

A. The student will develop an understanding of sets.

(M) 1. The student will be able to distinguish between infinite and finite sets.

B. The student will develop an understanding of whole numbers.

(D) 1. The student will be able to distinguish between composite and prime numbers.

(D) 2. The student will be able to distinguish between negative and positive integers with the use of an aid.

(D) 3. The student will be able to identify the basic numeral and given power.

(M) 4. The student will be able to demonstrate an understanding of the order relationship of a set of numbers from greatest to least and vice versa.

(I) 5. The student will be able to read numbers in bases other than ten.

(D) 6. The student will be able to identify the commutative and associative properties of addition and multiplication.

(D) 7. The student will be able to identify the distributive property of multiplication over addition.

C. The student will develop an understanding of rational numbers.

1. The student will be able to distinguish between the following:

(M) proper fractions

(M) improper fractions

(M) mixed fractions

(ID) 2. The student will be able to arrange a set of rational numbers in order from least to greatest and vice versa.

(M) 3. The student will be able to demonstrate his understanding of the relationship between common and decimal fractions (i.e., .75 = 3/4).

(M) 4. The student will be able to recognize and read the various forms of ratio (i.e., 1:2, or ½, or 1 to 2).

(ID) 5. The student will be able to understand the concept of a repeating decimal.

D. The student will develop an understanding of irrational numbers.

(ID) 1. The student will be able to recognize the symbol for pi.

(ID) 2. The student will be able to understand the value of pi.

II. Develop an ability to use mathematical notation.

A. The student will develop an understanding of names for numbers.

(I) 1. The student will be able to identify, read and write bases other than ten.

(ID) 2. The student will be able to identify, read and write base numbers with exponents.

(M) 3. The student will be able to identify, read and write Roman numerals through the thousands.

(I) 4. The student will be able to identify, read and write Egyptian numerals through the thousands.

B. The student will develop the ability to use the notation of whole numbers.

(M) 1. The student will be able to identify, read and write numerals to one trillion.

(M) 2. The student will be able to write word names for a given numeral to one trillion.

(M) 3. The student will be able to identify and name the place value of each digit of a 12-digit numeral.

(M) 4. The student will be able to write in expanded form and exponential form numerals to one trillion.

(M) 5. The student will be able to identify, read and write the word names for the period value of numbers.

(O) 6. The student will be able to identify, read and write numerals written in scientific notation.

C. The student will develop an understanding of integers.

(R) 1. The student will be able to associate points on a number line.

(O) 2. The student will be able to compare negative and positive integers with the use of a number line.

(ID) 3. The student will be able to read and write positive and negative numbers.

D. The student will develop the ability to use the notation of positive rational numbers.

(M) 1. The student will be able to simplify a proper fraction.

(M) 2. The student will be able to write a mixed numeral for an improper fraction and vice versa.

(M) 3. The student will be able to write a set of equivalent fractions.

(IM) 4. The student will be able to identify, name, read and write decimal numerals for rational numerals with denominators of ten, one hundred, and one thousand.

(IM) 5. The student will be able to identify, read and wirte word names for decimal fractions.

(IM) 6. The student will be able to write a decimal fraction in expanded form from millions to millionths.

(ID) 7. The student will be able to write a decimal fraction in a common fraction form.

(ID) 8. The student will be able to rename a decimal as a percent.

(ID) 9. The student will be able to classify a set of rational numerals as common fractions, decimal fractions, or percents.

III. Develop an ability to perform mathematical operations.

A. The student will develop the ability to perform the mathematical operations of whole numbers.

(M) 1. The student will be able to divide by a 3-digit divisor without a remainder.

(IM) 2. The student will be able to divide by a 3-digit divisor with a remainder expressed as a fraction.

(M) 3. The student will be able to solve problems by the "short division" method.

(IM) 4. The student will be able to compute average, median, or mean.

(M) 5. The student will be able to find the "greatest common factor" of two or more multiples.

(D) 6. The student will be able to find the "least common multiple" of two or more factors.

(D) 7. The student will be able to demonstrate the distributive property of multiplication over addition.

(D) 8. The student will be able to demonstrate the zero property in multiplication.

(D) 9. The student will be able to demonstrate the use of the identity element for addition and multiplication.

(ID) 10. The student will be able to demonstrate the standard name for a number written in a base and a given power (i.e., 5^3 - 125).

B. The student will develop the ability to perform the mathematical operation of positive rational numbers.

(M) 1. The student will be able to add and subtract all common fractional numerals.

(M) 2. The student will be able to solve equations using the inverse relationship of addition and subtraction.

(ID) 3. The student will be able to multiply and divide common fractional numerals.

(D) 4. The student will be able to add, subtract, multiply and divide decimal fractional numerals.

(ID) 5. The student will be able to demonstrate an understanding of the commutative and associative properties in addition and multiplication of common and decimal fractions.

(ID) 6. The student will be able to demonstrate an understanding of the distributive property of multiplication over addition as applied to rational numbers.

(ID) 7. The student will be able to demonstrate an understanding of the use of the zero and the identity properties in addition and multiplication.

C. The student will develop the ability to perform the mathematical operations of integers.

(D) 1. The student will be able to add and subtract positive and negative numbers with the use of a number line.

D. The student will develop an understanding of rounding numbers to a given place.

(M) 1. The student will be able to round off a numeral to the nearest thousandths, hundredths, tenths, ones, tens, hundreds, etc. place.

(M) 2. The student will be able to round off a numeral to the nearest millionths.

IV. Develop an understanding of Geometry.

A. The student will develop an understanding of geometric figures.

1. The student will be able to recognize and identify the following:

(M) vertex of angles
(ID) obtuse angles
(ID) acute angles

2. The student will be able to identify the parts of a circle:

(M) circumference
(ID) arc

3. The student will be able to identify the following space figures and their parts:

(M) cube (rectangular prism)
(M) sphere
(M) cylinder
(M) cone
(M) pyramid
(M) hemisphere
(ID) polyhedron
(ID) edge
(ID) face
(ID) base
(ID) height (altitude)

B. The student will develop an understanding of geometric properties.

(M) 1. The student will be able to sketch and define parallel, intersecting and perpendicular lines.

(M) 2. The student will be able to apply the rule for determining the perimeter of any polygon.

(ID) 3. The student will be able to determine the circumference of a circle when given the diameter.

(ID) 4. The student will be able to determine the area of any parallelogram.

(ID) 5. The student will be able to determine the area of any triangle.

(ID) 6. The student will be able to determine the volume of a cube (rectangular prism).

(ID) 7. The student will be able to determine the congruency of a pair of figures with the use of a model.

(ID) 8. The student will be able to write the symbol for congruency in an equation.

C. The student will develop the ability to construct geometric figures.

(M) 1. The student will be able to identify and use a protractor, compass, and a straightedge.

2. The student will be able to construct the following congruent figures:

(ID) angles
(ID) triangles
(ID) line segments

(ID) 3. The student will be able to bisect an angle using a compass and a straightedge.

4. The student will be able to construct the following with the use of a straightedge and a compass:

(D) perpendicular bisector
(D) perpendicular line at a given point on a line
(D) perpendicular line from a point not on a given line

(ID) 5. The student will be able to construct parallel lines with the use of a straightedge and a compass.

(D) 6. The student will be able to construct an intricate design using the compass.

V. Develop an understanding of Measurement.

A. The student will develop an understanding of measurement concepts.

(ID) 1. The student will be able to select the proper unit for the measurement of a physical object (i.e., angle, diamond, coal, liquid, boiling water, speed, etc.).

(D) 2. The student will be able to demonstrate his knowledge of the greatest possible error of measurement.

B. The student will develop an understanding of the measurement of physical properties.

(ID) 1. The student will be able to convert English measures to metric units and vice versa.

(ID) 2. The student will be able to express time in B.C. and A.D.

(O) 3. The student will be able to express distance in light years.

(D) 4. The student will be able to make change up to and including twenty dollars.

C. The student will develop an understanding of the renaming of units of measure.

1. The student will be able to convert and compare the following:

(ID) cubic foot-cubic inch
(O) Fahrenheit-Centigrade

(ID) 2. The student will be able to multiply and divide units of measure.

(ID) 3. The student will be able to add and subtract units of measure.

VI. Develop an application of mathematics.

(D) A. The student will be able to listen to or read a story problem and give a sum, a difference, a quotient, or a product.

(D) B. The student will be able to listen to or read a story problem and write a related mathematical sentence.

(D) C. The student will be able to demonstrate his ability to apply mathematical concepts and operations in daily situations.

VII. Develop an understanding and use of the mathematical terminology.

(ID) A. The student will be able to demonstrate the ability to add to his previous vocabulary the following mathematical terms:

arc
base
decimal numeral
diagonal
discount
divisible
greatest possible error
interest
inverse operations
isosceles triangle
mean (arithmetic average)
median (middle)
natural numbers (counting numbers)
obtuse angle
percent
prime factors
property of one for multiplication (identity element)
property of zero for addition
reciprocal
rectangular prism
region
repeating decimal
replacement set
rhombus
scalene triangle
subscript
variable

(ID) B. The student will be able to demonstrate his ability to add to his previous knowledge the following mathematical symbols:

not equal to ($\neq$)
three ways of writing multiplication (3.C, 3 x C, 3C)
three ways of writing division (4 ÷ 3, 4/3 $3\overline{)4}$)
base notation (42_5)
negative number (-n)
ten to the fifth power (10^5)
repeating decimal (.3 or .333.....)
pi (π), (approximately 3.14)
percent (%)

Example of Behavioral Instructional Objective:

Given a set of numbers such as 12, 15, 35, 36, the student can name the least common multiple of the numbers.

RESOURCES:

(All resources for grades 4-6 are included in the listing which follows.)

RESOURCES FOR THE INTERMEDIATE DEPARTMENT (4-6):

Books:

Text: Exploring Elementary Mathematics - Holt, Rinehart & Winston, 1970 (4-6)

Curriculum Library:

Modern Mathematics Through Discovery - Morton, Robert Lee; Silver Burdett Co., 1970
Thinking With Mathematics (with activity book) - American Book Co., 1969 (5)
Improving With Mathematics - American Book Co., 1969 (6)
Mathematics, Spectrum Series & Practice Sheets - Laidlaw Bros., 1971
Modern School Mathematics, Structure and Use - Houghton Mifflin, 1970
Moving Ahead in Arithmetic - Holt, Rinehart & Winston, 1963
Merril Modern Arithmetic - Merril, Charles E., 1963
Discovering Mathematics - Merril, Charles E., 1963
New Dimensions in Mathematics - Harper & Row, 1970
Exploring Elementary Mathematics Exercises - Hunte, Beryl E., 1970
Essential School Mathematics - Ginn & Co., 1970

Central Library:

Number Concept - Adler, Irving; Day, 1960
Numbers Old and New - Adler, Irving; Day, 1960
Theory of Numbers - Adler, Irving; Day, 1960, 512
Theory of Numbers - Bendick, Jenne; McGraw, 1961
Numerals - Adler, Irving; Day, 1964, 512
How to Build Coin Collection - Reinfeld, Fred; Sterling Co., 1959, 737.4
Puzzles - Adler, Irving; Day, 1962, 793.7
Sets - Adler, Irving; Day, 1967, 510
Money Makes Sense - Kahn, Charles H.; Fearon Publishers, 1960, 511
Mathematics: First S T E P S - Lieber, Lillian; Franklin Watts, Inc., 1963
The Wonderful World of Mathematics - Heghen, Lancelot; Garden City, 1955
How and Why Wonder Book of Mathematics - Highland, Esther & Harold; Grosset, Dunlap, 1961
Modern Math Grade by Grade - May, Lola J.; Grade Teacher, 1965 (5,6)
Fun With Figures - Freeman, Mae & Ira; Random House, 1946, Geom
Math Projects: Polyhedral Shapes - Bassetti, Fred; Book Lab Inc., 1968

High School Library:

Patterns and Puzzles in Mathematics - Horne, Lylvia; Lyons & Carnehan, 1970
Learning About Measurement - Lyons & Carnahan, 1970
Mathematics Around the Clock - Willerding, Margaret; Lyons & Carnahan, 1970
How to Take a Chance - Huff, Darrell and Geis; W. W. Norton, 1959, 519.1
Probability: The Science of Chance - Willerding, Margaret; Lyons & Carnahan, 1970, 510
Mathematical Teasers - Mira, Julio; Barnes & Noble, Inc., 1970, 510
Paper Folding for the Mathematics Class - Johnson, Donovan; NCTM, 1957, 510
Mathematical Models - Cundy, H. Martin; Oxford University Press, 1961, 510
String, Straightedge and Shadow: The Story of Geometry - Diggins, Julia E.; Viking Press, 1965, 513
An Adventure in Geometry - Varielli, Anthony; Viking Press, 1965, 513
Paper and Pencil Geometry - Roper, Susan; Lyons & Carnahan, 1970, 513

Filmstrips:

Five Keys to Mathematics (background to reason for math), 511
Non-Decimal Numerals, 186-B (6)
Tests for Divisibility, 186-C (6)
The Rational Numbers of Arithmetic, 186-D (6)
Segments and Polygons, 186-G (6)
Congruent Figures, 186-H (6)
Bisecting Angles and Segments, 186-I (6)
Using the Mathematics You Know, 186-J (6)
Multiplying and Dividing, A 537-24 (6)
Elementary Mathematics: Two Properties of Addition - Communtative and Associative, 4H-2 (4-6)
Linear Measure, 511 (4)
Non-Unit Fractions of a Whole and Groups
Fractional Parts of Groups, 511t
Fractional Parts of a Whole Group, 511u
Comparing Fractions, 511w
Comparing Fractional Numbers, 4H-6 (4)
Division Algorithms, 4H-5 (4,5)
Multiplication and Distributive Property, 4H-4 (4)
Expanded Numerals, 4H-1 (4)
Rays and Angles, 4H-7 (4)
Perimeter, 4H-8 (4,5)

8 mm Filmloops:

Set Relations (Venn Diagram), (5)
Flow Charts (Sequence and Meaning), (4)

Charts:

Associative Property (4,5,6)
Communtative Property (4,5,6)
Geometric Symbols (4,5,6)
Set Symbols (4,5,6)

Kits, Games and Models:

Fraction Discs - Milton Bradley Co.
Modern Computing Abacus (large) - Ideal Supply Co.
Table Tamer (battery operated)-aid to multiplication and division
Cuisenaire Rods
Chess - Pressman, 794.1
Cross Number Puzzles (addition - Advanced), 797
Instructo Kits - Flannel Board Material:
- Number Line
- Numbers
- Reading Whole Numbers
- Modern Math Vocabulary and Symbols

Division Answer Game (battery operated)
Tuf (game using dice), (6)
Math Wheel (fraction and percents), (6)
Pay the Cashier - game of making change
Smarty (arithmetic bingo)
Quizmo (bingo multiplication)
Numble - Crossword
Winning Touch (multiplication facts)

Geometry Models (4,5,6)
Volume Relationship Set (cube, pyramid, sphere, cone), 779
Geometric Forms, 7854
Geometric Solids, 17 plane figures, 22 solid figures

Flash Cards:

Subtraction, 787
Addition Set #1, 786
Division
Multiplication (small cards)
Addition (small cards)

Paperback Books:

The Math Wizard (Riddles, Tricks, Puzzles) - Brandes, Louis Grant
Fun With the New Math - Hanlon, Stuart; Fawcett Publishing Inc., 1965
Modern Math Games, Activities and Puzzles - Thomason, Mary E.: Fearon, 1970
Arithmetic Games - Dumas, Enoch
Games - Gardner, Martin (brain teasers, words, optical illusions), 793.7

Magazine Articles:

"Try Multiples of Ten" = Kraut, Evelyn S, Instructor, Aug. Sept., 1968
"Conic Sections in Relation to Physics and Astronomy" - Baravalle, Herman; The Mathematics Teacher, Vol. LXIII, Number 2, Feb., 1970 (construction designs)

Transparencies (High School Media Center) (Grades 5,6):

Optical Illusions (Math #28), 512
Brain Teasers, 510
Unions, Intersections of Lines, Planes, 510
Plane and Solid Figures, 510
Fundamentals, 511
Sets and Sentences, 512
Measuring and Using the Circle, 510
Geometric Construction with Lines, Angles, Triangles, 513
Geometric Construction With Circles and Polygons, 513
Fundamental Operations, 511
Numeration Systems, 512
Unions, Intersection of Lines, Planes, 510
Plane and Solid Figures, 510

Drill and Practice Kit (Individualized Mathematics) by Singer Co.

APPLICATION OF MATHEMATICS

GRADE SEVEN

I. Develop an understanding of numbers and numerals.

(M) A. The student will demonstrate a thorough understanding of sets.
(M) B. The student will demonstrate a workable knowledge of numbers through the set of rational numbers.
(D) C. The student will be able to recognize other numeration systems that are similar to ours.
(M) D. The student will be able to recognize the greatest common factor and least common multiple.
(D) E. The student will recognize that numbers can be expressed as a number to a power.
(M) F. The student will be able to demonstrate an understanding of decimal numerals in base ten.
(D) G. The student will understand and apply the comparison property to rational numbers.

II. Develop an understanding of number sentences.

(M) A. The student will be able to recognize a variable in a mathematical sentence.
(M) B. The student will be able to distinguish between an equation and an inequality.

III. Develop the ability to perform mathematical operations.

(M) A. The student will be able to demonstrate the ability to perform the four basic operations using the set of non-negative rational numbers.
(D) B. The student will be able to raise a base to the power of its exponent.
(D) C. The student will be able to work with ratios, proportions, and percents.
(ID) D. The student will be able to demonstrate the ability to perform the basic operations using the set of integers.

IV. Develop an understanding of geometry.

(M) A. The student will recognize that points, lines, and planes are the fundamental basis of plane geometry.
(M) B. The student will be able to perform basic constructions in plane geometry.
C. The student will be able to perform the following measurements:
(R) length of a line segment
(M) measure of an angle
(M) perimeter of a polygon
(D) circumference of a circle
(D) area of a plane figure
(ID) surface area of a rectangular solid
(D) volume of a right rectangular prism

V. Develop an understanding of measurement.

(D) A. The student will recognize precision and accuracy in measuring.
(M) B. The student will realize that the greatest possible error is one half the unit of measure.

VI. Develop an understanding of functions and relations.

(M) A. The student will graph numbers on a number line.
(I) B. The student will recognize that a relation is a set of ordered pairs.

VII. Develop an application of mathematics.

(D) A. The student will develop a method for problem solving.
(ID) B. The student will demonstrate his ability to add to his previous vocabulary the following terms:

adjacent angles	half-space	secant line
altitude	half-line	semi-circle
binary	improper subset	skew lines
central angle of a circle	logarithms	space
closure property	means	straight angle
colinear	mode	supplementary angles
comparison property	negative integer	tangent line
complimentary angle	null set	terminating decimal
coordinate	origin	variable
coplanar	percentage	vertical angles
decagon	proportion	universal sets
density	rectangular prism	ordered pairs
disjoint sets	relation	
extremes	relatively prime numbers	

Example of Behavioral Instructional Objective:

The student will take a straightedge and a compass and bisect an acute angle.

RESOURCES:

Books:

Text: Modern School Mathematics - Structure and Method: Grade 7 - Houghton & Mifflin

Sample Texts:
Basic Modern Math: Course 1 - Addison-Wesley
Discoveries in Modern Mathematics: Book 1 - Merrill
Elementary Mathematics - Grade 7 - Holt, Rinehart & Winston
Exploring Modern Mathematics: Book 1 - Holt, Rinehart & Winston
Harbrace Mathematics - Grade 7 - Harcourt, Brace & World
Mathematics: Concepts & Applications - First Course - Scott Foresman
Mathematics - Grade 7 - McGraw and Hill
Mathematics We Need - Ginn
Modern Mathematics: Book 1 - Singer
Modern Mathematics Through Discovery - Grade 7 - Silver Burdett
Seeing Through Mathematics: Book 1 - Scott Foresman
Structuring Mathematics - Grade 7 - American Book Company

Library Books:
Mathematics: Exploring the World of Numbers & Space - Adler, Irving, 510 A
Making and Using Graphs & Non Graphs - Denholm, Richard A., 510 Den
The Wonderful World of Mathematics - Hogben, Lancelot, 510.9 Hog
Mathematics, First Steps - Lieber, Lillian, 511 Lie

Filmstrips:

Measurement With Dials, Calipers and Micrometers, 510.78
Multiplication and Division, NT 511q
Positive and Negative Numbers, NT 512b

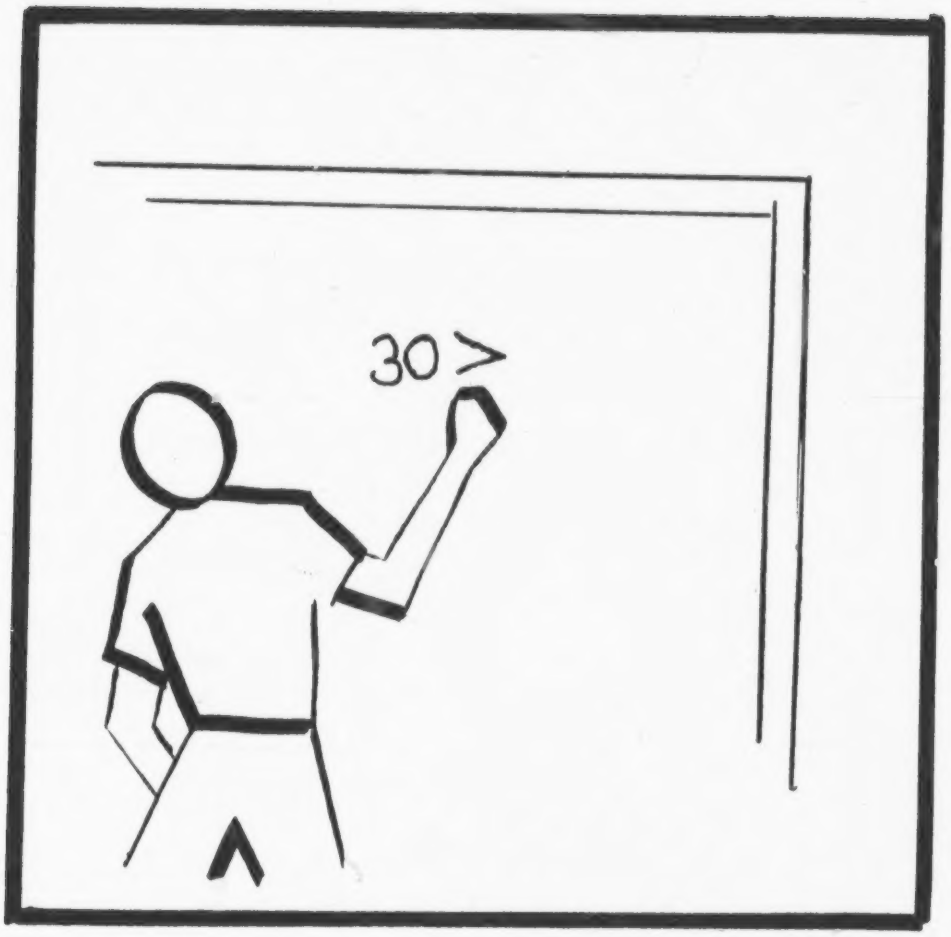
Ratios and Proportions, NT 512C
Introduction to Sets, NT 512.01
Multiplication of Signed Numbers, NT 512y
Meaning of Signed Numbers and How to Add Them, NT 512ac
Using the Mathematics You Know, A 511/f
Segments and Polygons, C 511/f
The Counting Process,NT 511/f
Tests for Divisibility, NT 511/f
The Rational Numbers of Arithmetic, NT 511/f
Non-Decimal Numerals, NT 511/f

Transparencies:

Union, Intersection of Lines and Planes, G 510 Uni
Plane & Solid Figures, G 510 Pla
Sets and Sentences, NT 512 Set

Games and Kits (available for 7 - 12):

Metric Scales Tables, 510 Met
Napier's Bones, 510 Nap
Computational Skills Development Kit, 510 Com
Gravity Protractor, 510 Gra
Graph Board, 510.78 Gra
Measuring Packet, 510.78 Mea
Ruler - straightedge, 510.78 Rul
Radian Protractor, 510.78 Rad
T-Square, 510.78 T-sq
Trianguler Ruler, 510.78 Tri
Trig. tracer, 510.78 Tri
Pythagorean theorem model, 511 Pyt
Place value game, 511 Pla
Modern Computing abacus, 511 Mod
Geometry 82 Kit, 511 Geo
Student Spplied Geometry Experiment Kit, 513 Sag
Compasses, protractors, rulers, graph charts, 513
Tuff, Avalon Hill Company
Numble, Selchow and Righter Company
Geobarod, Creative Publications
Tic-Tac-Toe, James Lang; Mound, Minn.
Kalak Game, Calak Game Company
Space Tic-Tac-Toe, Creative Publications
Crypto, Creative Publications
Bali-Buttons, Creative Publications
Lucky Seven Puzzle, Creative Publications
Equations, Creative Publications
Prime Drag, Creative Publications
Math Match, Creative Publications
Tac-Tickle, Creative Publications
Cubic, Parker Brothers, Inc.
Polyhedron Models, National Council of Teachers of Mathematics
Burns Board, Ideal
Geo-Board, John Triy II
Activity Card
Cuisenaire Rods, Cuisenaire Company



FUNCTIONS AND RELATIONS

GRADE EIGHT

I. Develop an understanding of numbers and numerals.

(R) A. The student will demonstrate a complete comprehension of the rational number system.
B. The student will display an understanding of exponents.
(ID) 1. The student will work with exponents that are integers.
(ID) 2. The student will be able to write numbers in scientific notation.
(M) C. The student will demonstrate a knowledge of the comparison property (law of trichotomy).
(ID) D. The student will be able to recognize irrational numbers.
(ID) E. The student will be able to identify absolute value.

II. Develop an understanding of number sentences.

(D) A. The student will be able to solve first-degree equations containing one variable.
(ID) B. The student will be able to solve first-degree inequalities containing one variable.
(ID) C. The student will be able to solve first-degree equations containing two variables.
(ID) D. The student will be able to solve first-degree inequalities containing two variables.

III. Develop the ability to perform mathematical operations.

(R) A. The student will demonstrate that he can perform the operations of addition, subtraction, multiplication, and division using rational numbers.
(ID) B. The student will be able to extract square roots resulting from the application of the Pythagorean property.
(ID) C. The student will be able to determine the sine, cosine and tangent of an angle.

IV. Develop an understanding of geometry.

(R) A. The student will construct plane geometric figures.
B. The student will compare plane geometric figures.
(M) 1. The student will understand the meaning of congruence and recognize congruent figures.
(M) 2. The student will express an understanding of similar figures.
C. The student will be able to perform the following measurements:
(R) measure of an angle
(M) perimeter of a polygon
(M) circumference of a circle
(M) area of a plane figure
(D) surface area of a solid
(M) volume of a rectangular prism
(ID) volume of pyramid and cone
(ID) volume of a cylinder
(ID) volume of a sphere
(ID) D. The student will prove the congruency of triangles using the ASA, SAS and SSS properties.

V. Develop an understanding of measurement.

A. The student will be able to utilize the metric system for the following measures:

(D) length
(ID) volume
(ID) area
(ID) seight

(M) B. The student will understand the meaning of precision and accuracy.
(R) C. The student will be able to state the greatest possible error of a measurement.
(ID) D. The student will be able to find the relative error of a measurement.
(ID) E. The student will be able to express relative error as a percent of error.
(ID) F. The student will be able to determine which digits are significant.

VI. Develop an understanding of functions and relations.

(D) A. The student will demonstrate an understanding of the concepts of relations and functions in one and two variables.
(D) B. The student will be able to graph ordered pairs on a rectangular coordinate system.
(ID) C. The student will be able to graph linear equations.
(ID) D. The student will be able to graph linear inequalities.

VII. Develop an application of mathematics.

(D) A. The student will be able to apply mathematics to the solving of word problems.

(ID)VIII. Develop an understanding and use of mathematical terms.

abscissa
absolute value
accuracy
additive inverse
alternate exterior angles
alternate interior angles
circular cone
circular cylinder
constant
corresponding angles
cosine
domain of a relation
equivalent equations
exterior angles
formula
functions
hypotenuse
interior angles
irrational numbers
linear equation
liter
mass
oblique
open number sentences
ordinate
percent of error
polyhedron
pyramid
Pythagorean property
quadrant
range of a relation
real numbers
rectangular coordinate system
relative error
root
set builder notation
significant digits
sine
slant height
solution set
square root
statement
system of equations
transformation
transversal
trigonometric ratio

Example of Behavioral Instructional Objective:

The student will be able to find the percent of error in a measurement of 5-3/4 feet.

RESOURCES:

Books:

Text: Modern School Mathematics - 8 - Houghton and Mifflin

Sample Texts:
Basic Modern Mathematics: Course 2 - Addison-Wesley
Discoveries In Modern Mathematics: Book 2 - Merrill
Elementary Mathematics - Grade 8 - Holt, Rinehart & Winston
Exploring Modern Mathematics: Book 2 - Holt, Rinehart & Winston
Foundations of Mathematics - Holt, Rinehart & Winston
Harbrace Mathematics - Grade 8 - Harcourt, Brace & World
Mathematics: Concepts & Applications - Second Course - Scott Foresman
Mathematics - 8 - McGraw Hill
Mathematics We Need - Grade 8 - Ginn
Modern Mathematics: Book II - Singer
Modern Mathematics Through Discovery: Book II - Silver Burdett
Seeing Through Mathematics: Book II - Foresman

Library Books:
Mathematics: Exploring the World of Numbers and Space (measurement and number symbols, etc.) - Adler, Irving, 510 A (NT&M)
Realm of Numbers - Asimov, Isaac, 510 A (NT)
Making and Using Graphs & Nongraphs - Denholm, Richard A., 510 Den (NT)
Mathematics: Man's Key to Progress, Book A - Denholm, Richard A., 510 Den (M)

Micro-filmstrips:

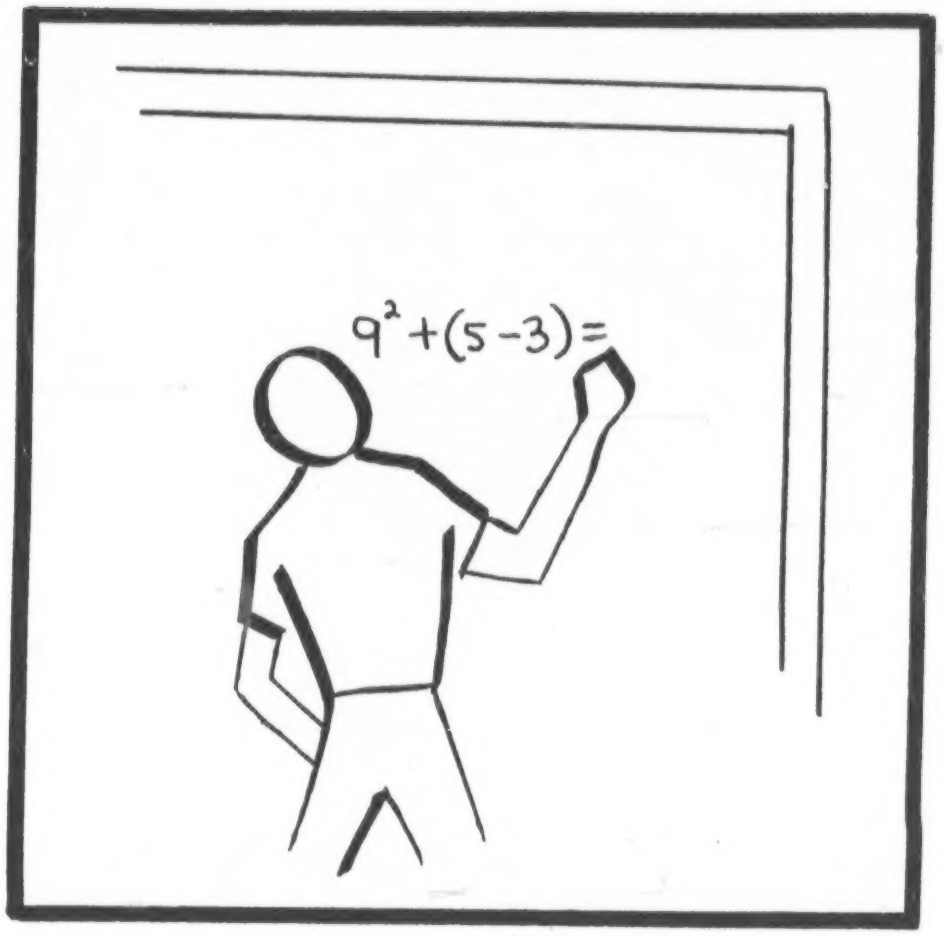
Segments & Polygons, 511/f Geom
Finding Square Roots, 511 NT
Bisecting Angles and Segments, 511 Geom
Pythagorean Triples, 511 NT
Congruent Figures, 511 Geom

Filmstrips:

Measurement With Dials, Calipers & Mocrometers, with guide, 510.78(M)
Metric System, with guide, 510.83 (M)
Square Root & Cube Root, 511 K (NT)
Place Value, 512 b-1 (NT)
Ratios & Proportions, 512 c (NT)
Problem Analysis, 512 g (A)
Functions, Graphs, Relations, 512 n (NT)
Using Approximations, with guide, 512 s
Proof in Algebra: Solving Equations, with guide, 512 u (NT)
Equivalent Equations, with guide, 512 w (NT)
Equalities & Inequalities, 512 ab (A)
Graphs of Inequalities in one variable, with guide, 512 aa (NT)
Topology, 513 (A)
Angular Method, 513 a (G)
Addition and Subtraction in Geometry, 513 b (G)
Multiplication and Division in Geometry, 513 c (G)
Similar triangles - experiment and deduction, with guide, 513 g-1 (G)
Parallelograms and Their Properties, with guide, 513 h-1 (G)
Trigonometry, 514 (NT)

Transparencies:

Unions, Intersections of Line and Plane, NT 510 Uni
Measuring and Using the Circle, G 510 Mea
Plane and Solid Figures, G 510 Pla
Numeration Systems, NT 512 Num
Sets and Sentences, NT 512 Set
Geometric Construction, with lines, angles and triangles, G 513 Geo
Guide: 3-dimensional Models, G 513 Dim
Pythagorean Theorum, G 513 Pyt



NUMBER SENTENCES

GRADE NINE

GENERAL MATHEMATICS I

I. Develop an understanding of numbers and numerals

(D) A. The student will compare ancient number systems to the Hindu-Arabic system of numeration.
(D) B. The student will study other bases for a better understanding of the base ten (decimal) system.
(ID) C. The student will recognize approximate and exact numbers.

II. Develop an understanding of number sentences.

A. The student will further study the general methods for solving equations.
(D) 1. The student will solve first-degree equations by using the property of addition.
(D) 2. The student will solve first-degree equations by using the property of multiplication.
(D) B. The student will be able to solve word problems through the use of formulas.

III. Develop an understanding of geometry.

(D) A. The student will demonstrate a workable knowledge of the basic concepts of geometry.
B. The student will be able to compute the following measurements:
(R) area of a plane figure
(D) volume of a right prism

IV. Develop the ability to perform mathematical operations.

(R) A. The student will be able to determine the greatest possible error.
(M) B. The student will be able to compute relative error.
(M) C. The student will be able to convert and compare the metric system to the English system and vice versa.
(R) D. The student will measure temperature in Centigrade and Fahrenheit.
(ID) E. The student will be able to solve problems involved with electricity.
(ID) F. The student will be able to solve problems involving mechanical measurements.

V. Develop an understanding of probability.

(ID) A. The student will be able to classify a group of objects as a permutation or a combination.
(ID) B. The student will be able to compute the possible number of permutations and combinations.
(ID) C. The student will be able to compute the probability of a favorable event.

VI. Develop an application of mathematics.

(D) A. The student will be able to apply previously learned material to problem solving situations.
(ID) B. The student will construct line graphs, bar graphs, and circle graphs to show statistical information.

VII. Develop an understanding and use of a mathematical terminology.

(ID) A. The student will demonstrate his ability to add to his previous vocabulary the following terms:

arithmetic progression	dependent events	line graph
bar graph	dimensions	permutations
capacity	Hindu-Arabic numeration	probability
circle graph	horizontal	sample space
combinations	independent events	statistics

Example of a Behavioral Instructional Objective:

Given the dimensions of a truck box, the student will calculate the capacity of this box in bushels.

RESOURCES:

Books:

Texts: General Mathematics: A Problem Solving Approach: Book One - Holt, Rinehart & Winston
Trouble Shooting Mathematics Skills - Holt, Rinehart & Winston

Sample Texts:
Basic Mathematics: Book I - American Book Company
Developing Mathematical Ideas: Book I - Ginn
Exploring Modern Mathematics: Book III - Holt, Rinehart & Winston
Fundamentals of Mathematics - Holt, Rinehart & Winston
Fundamentals of Mathematics: First Course - Allyn & Bacon
General Mathematics - Holt
General Mathematics - Singer
General Mathematics: Book I - Laidlaw
Mathematics, A Modern Approach: Book 1 - D. Van Nostrand
Mathematics at Work - Heath
Mathematics In Daily Use - Heath
Mathematics to Use - Ginn
Modern General Mathematics - Addison & Wesley
Refresher Mathematics - Allyn & Bacon
Using Modern Mathematics - Singer

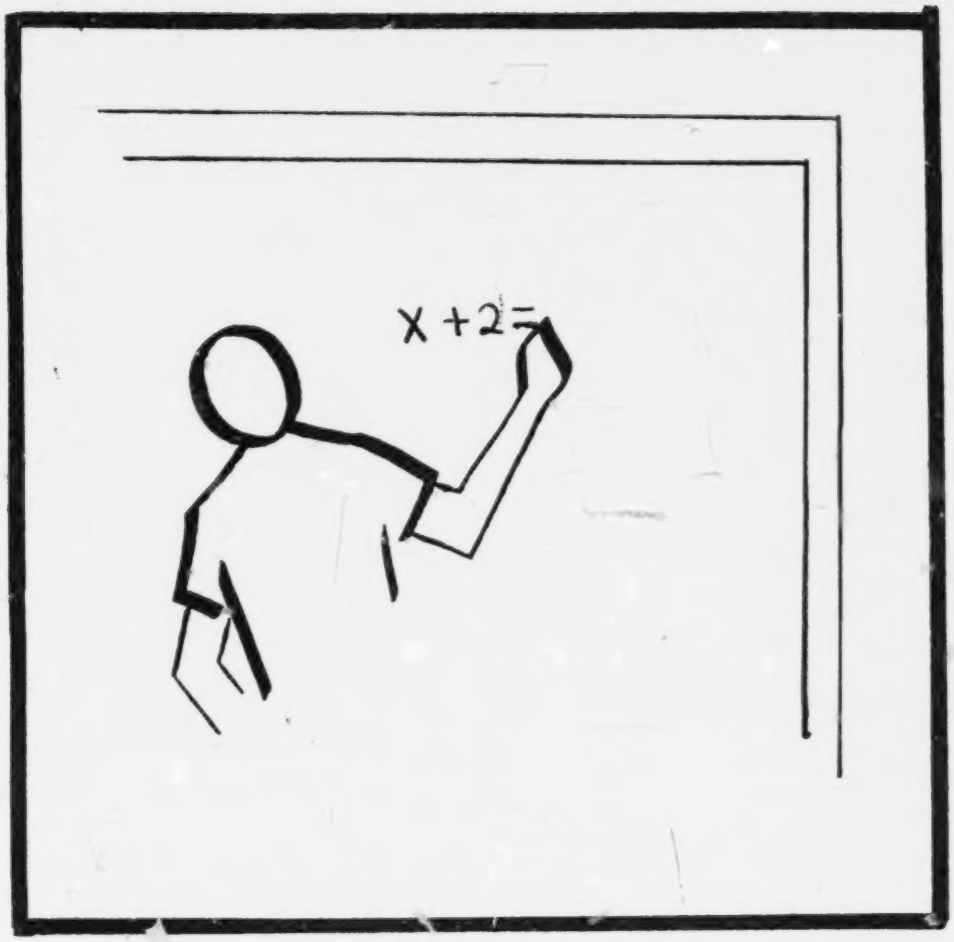
Library Books:
The Nature of Number - Dubish, Roy, 510 Dub (NT)
Mathematics: Man's Key to Progress, Book B - Denholm, Richard A., 510 Den (NT)

Filmstrips:

Place Value, 512b-1 (NT)
Introduction to Probability, 512m (A)
Congruent Figures, 512/f Geom
Graph Uses, 511n (A)

Transparencies:

Introduction to Probability, 510 Int (A)
Unions, Intersections of Lines and Planes, 510 Uni Geom
Measuring and Using the Circle, 510 Mea Geom
The Abacus, 510.78 Aba (A)
Numeration Systems, 512 Num (NT)



ALGEBRA I

GRADE NINE

ALGEBRA I

I. Develop an understanding of numbers and numerals.

A. The student will have a workable knowledge of the real number system.
(R) 1. The student will be able to distinguish between rational and irrational numbers.
(M) 2. The student will realize that the real number system has the property of density.
(M) B. The student will demonstrate comprehension of the order in the set of real numbers.
(ID) C. The student will become familiar with powers in numerical expressions.

II. Develop an understanding of algebraic number sentences.

(M) A. The student will solve first-degree equations and inequalities with two variables.
(ID) B. The student will be able to calculate the slope of a line.
C. The student will be able to solve systems of linear equations by the following:
(ID) 1. Elimination of one variable by addition-subtraction.
(ID) 2. Elimination of one variable by substitution.
(ID) 3. Graphing of linear equations.
(ID) D. The student will be able to solve systems of linear inequalities.
E. The student will be able to solve quadratic equations by the following methods:
(ID) 1. Completing the square.
(ID) 2. Quadratic formula
(ID) 3. Radical equations which have to be squared.

III. Develop an understanding of algebraic operations.

(ID) A. The student will be able to add, subtract, multiply and divide using real numbers.
(D) B. The student will be able to calculate square roots.
(ID) C. The student will be able to find the sum of radical expressions.
(ID) D. The student will be able to compute the product of radical expressions.

IV. Develop an understanding of polynomials.

(ID) A. The student will demonstrate an understanding of the following laws of exponents:
multiplication law
division law
negative and zero exponents
(ID) B. The student will be able to determine the product of two polynomials.
(ID) C. The student will be able to divide a polynomial by another polynomial.
(ID) D. The student will be able to perform the following in reference to rational expressions:
simplification
sum
difference
solving of equations.
(ID) E. The student will be able to factor polynomials.

V. Develop further understanding of functions and relations.

(D) A. The student will be able to write the domain and range of a relation.
(ID) B. The student will become familiar with function notation.
(ID) C. The student will graph parabolas and circles.
(ID) D. The student will be able to work with the following variations:
direct variation
indirect or inverse variation
joint or combined variation
(ID) E. The student will be able to determine a linear equation given the slope and y-intercept of the line.
(ID) F. The student will derive the distance formula.

VI. Develop an understanding and use of a mathematical terminology.

argument
assumption
axiom
binomial
cartesian coordinate system
cartesian product
coefficient
combined variation
complete factorization
conclusions
conjugate expressions
conjuction
consistant system of equations
constant
constant function
constant variation
cube root
degree of polynomial
difference of squares
direct variation
discriminant of a quadratic equation
disjunction
factoring
fractional equation
identity
inverse variation
joint variation
linear functions
maximum point
minimum point
numerical expression
quadratic equation
quadratic formula
quadratic function
polynomial
radicals
radical equation
radicand
rational expression
real number
reflexive property
slope of a line
symmetric property
transitive property
y-intercept

Example of a Behavioral Instructional Objective:

Given two equations in the form ax + by = c, the student will find those values for x and y which will make the two equations true simultaneously.

RESOURCES:

Books:

Text: Modern School Mathematics: Algebra I - Houghton & Mifflin

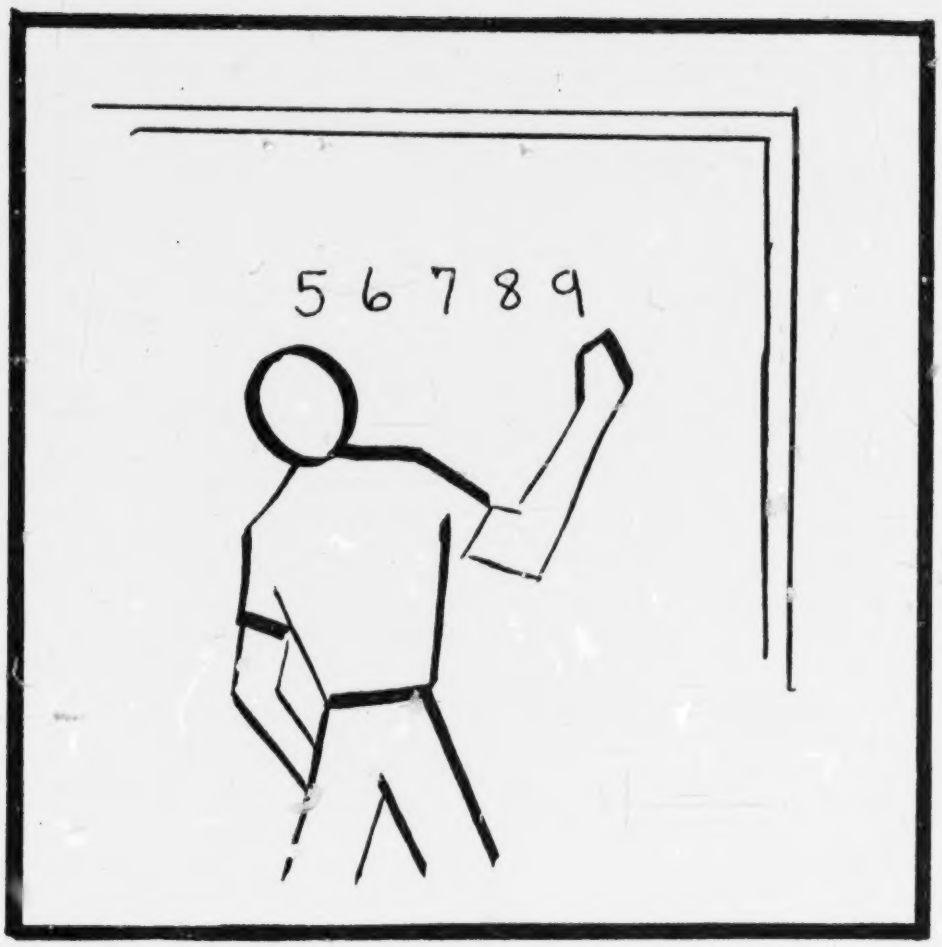
Sample Texts:
Algebra - MacMillian
Algebra - Scott Foresman
Algebra I - Ginn
Algebra I - Hartcourt, Crace and World
Algebra I - Laidlaw

Algebra I: A Modern Approach - D. Van Nostrand
Albegra I: A Modern Course - Merrill
Exploring Modern Mathematics: Book III - Holt, Rinehart & Winston
Fundamentals of Algebra: Book I - Allyn & Bacon
Introductory Algebra - Harcourt, Brace and World
Modern Algebra: Book I - McGraw-Hill
Modern Algebra: Book I - Ginn
Modern Elementary Algebra - Holt, Rinehart & Winston
Modern Mathematics: Book III - Silver Burdett
Seeing Through Mathematics: Book III - Scott Foresman

Library Books:
Exploring Mathematics On Your Own - Glenn, William H. and Johnson, Donovan A., 510 Gle (NT)

Filmstrips:

Plotting Graphs, 512a (NT)
Arithmetic of Algebra, 512e (NT)
Equations and Formulas, 512f (NT)
Basic Definition of Algebra, 512i (NT)
Origin of Algebra, 512j (A)
Saying It In Algebra, with guide, 512o (NT)
Quadratic Equations and Their Solutions, with guide, 512t (NT)
The Slope of a Line, with guide, 512x (NT)
Proofs in Algebra, 512u (NT)



NUMBERS AND NUMERALS

GRADE TEN

GENERAL MATHEMATICS II

I. General review of fundamentals.

(R) A. The student will review the fundamentals of the real number system to strengthen his understanding.

B. The student will enhance his study of equations and inequalities in one and two variables.

(M) 1. The student will solve mathematical sentences with one or two variables.

(M) 2. The student will graph mathematical sentences with one or two variables.

II. Develop the ability to apply geometry concepts to applicable situations.

(D) A. The student will be able to calculate areas of plane figures in occupational situations.

(D) B. The student will be able to calculate volumes of three dimensional figures in occupational situations.

(ID) C. The student will demonstrate how to use geometry in construction of buildings.

III. Develop the use of mathematics in business.

(ID) A. The student will be aware of expenses involved in business.

(ID) B. The student will be able to calculate profit.

(ID) C. The student will be able to determine selling price.

(ID) D. The student will be able to compute discounts, interests and commissions.

IV. Develop an understanding of mathematics in the community.

(ID) A. The student will be able to demonstrate his knowledge of state and federal budgets.

(ID) B. The student will be able to compute direct and indirect taxes.

V. Develop an understanding of consumer credit.

(ID) A. The student will demonstrate a knowledge of installment buying and time payments.

(ID) B. The student will be able to compute interest and outlaying principle on loans.

VI. Develop an understanding of personal income management.

(ID) A. The student will be able to make use of a checking account.

(ID) B. The student will demonstrate a knowledge of planning a personal budget.

(ID) C. The student will signify his knowledge of investing money into stocks and bonds.

VII. Develop an understanding of the expenses of an automobile.

(ID) A. The student will be aware of the fixed and variable expenses of an automobile.

(ID) B. The student will demonstrate a knowledge of the cost involved in purchasing an automobile through installment buying.

(ID) C. The student will realize the necessity of automobile insurance.

VIII. Develop a knowledge of other types of insurance.

(ID) A. The student will become familiar with fire and household insurance.
(ID) B. The student will become familiar with health and accident insurance.
(ID) C. The student will become familiar with life insurance.

IX. Develop an understanding and use of a mathematical terminology.

(ID) A. The student will demonstrate his ability to add to his previous vocabulary the following mathematical terms:

bankruptcy	indirect taxes	premium
car charge	installment buying	profit
checking account	insurance	margin
collision insurance	interest	property tax
commissions	liability insurance	real estate
comprehensive insurance	market value	repression
deposit slip	mill	sales tax
depreciation	overtime pay	selling price
direct taxes	payroll	time payments
down payment	personal loan	withholding tax
fixed expenses	policy holder	

Example of a Behavioral Instructional Objective:

Given the initial cost, number of payments, and the amount of each payment, the student will calculate the amount of interest paid when buying an automobile on the installment plan.

RESOURCES:

Books:

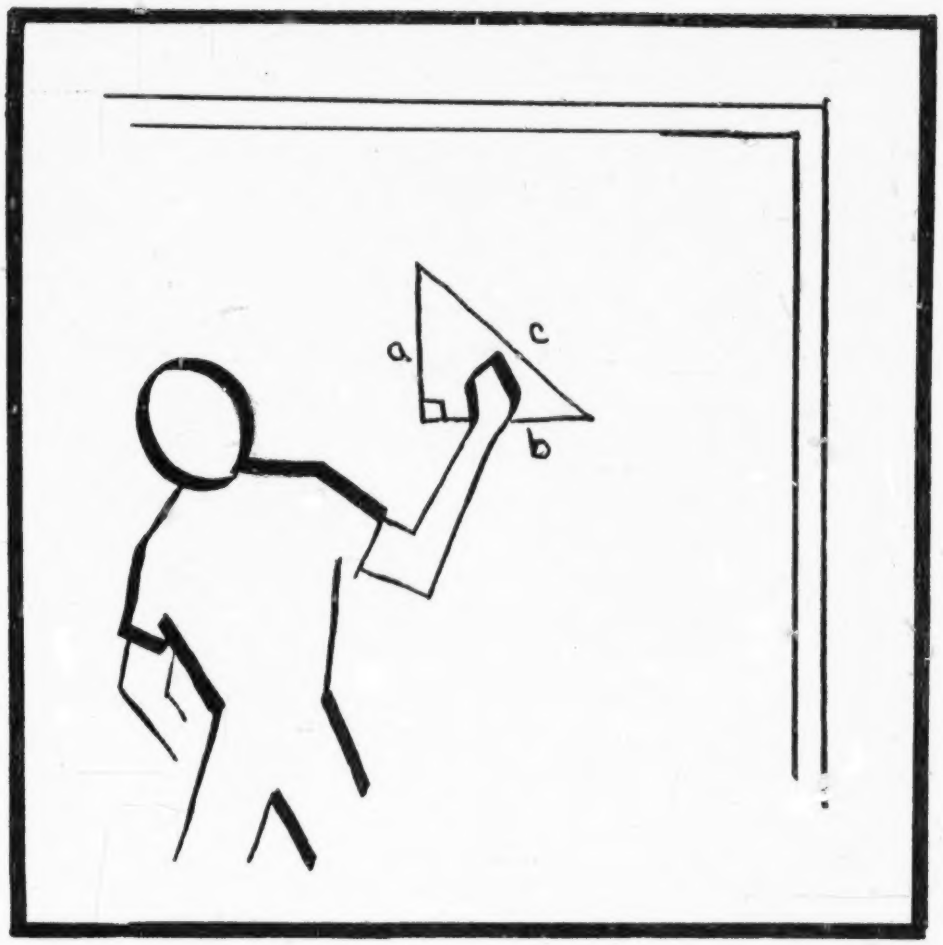
Text: General Mathematics: A Problem Solving Approach, Book II - Holt, Rinehart & Winston

Sample Texts:
Basic Mathematics: Book II - American Book Company
Contemporary Mathematics - Prentice Hall
Developing Mathematical Ideas: Book II - Ginn
Everyday Problems in Mathematics - Houghton & Mifflin
Fundamentals of Mathematics: Second Course - Allyn & Bacon
General Mathematics: Book II - Laidlaw
Mathematics In Life - Heath
Refresher Mathematics - Allyn & Bacon

Library Books:
Mathematics: Its Magic and Mastery - Bakst, Aaron, 510 Bak (NT)
Mathematics - Bergamini, David, 510 Lh (A)
Mathematics in Everyday Things - Vergara, William, 510 (A)

Filmstrips:

Graphical Methods, Slide Rules, Solving Equations, 512h (A)
Scale Drawing, with guide, 512g (A)
Scales and Models, 513g (A)
An Introduction to Probability, with guide, 519 (A)
Graph Uses, 511n (A)



GEOMETRY

GRADE TEN

GEOMETRY

I. Develop an understanding of the concepts used in geometry.

(M) A. The student will demonstrate how sets are used in geometry.
(M) B. The student will show understanding of the basic terms and definitions used in geometry.
(M) C. The student will demonstrate a knowledge of angles and angle relationships.

II. Develop a formal process for geometric proofs.

(D) A. The student will develop ideas by logical reasoning.
(D) B. The student will show an ability to use both deductive and inductive reasoning in formal proofs.
(D) C. The student will develop an understanding of postulates and theorems.
D. The student will be able to prove geometric concepts and properties concerning the following:
(M) 1. Angles (right, obtuse, acute).
(M) 2. Supplementary and complementary angles.
(M) 3. Adjacent and vertical angles.
(M) 4. Polygons.
(M) 5. Parallel, perpendicular and skew lines.
(I) E. The student will be familiar with the method of indirect proof.

III. Develop an ability to perform geometric constructions.

A. The student will be able to construct with a straightedge and compass the following:
(R) 1. Triangles.
(R) 2. Angles and angle bisector.
(R) 3. Parallel lines.
(R) 4. Perpendiculars.
(R) 5. Circles.
(ID) 6. Tangents to a circle.
(R) 7. Lines and bisector of a line.
(ID) 8. Circles circumscribed around a polygon.
(ID) 9. Circles inscribed within a polygon.
(ID) 10. Bisectors of arcs and chords of a circle.

IV. Develop an understanding of polygonal relationships.

(R) A. The student will be able to compute the perimeter of polygons.
(M) B. The student will demonstrate an understanding of the congruen , erties of polygons.
(M) C. The student will show an understanding of similar polygons and their relationships.
(M) D. The student will demonstrate an understanding of the different quadrilaterals and their properties.
(M) E. The student will demonstrate an understanding of triangles and their existing relationships.
(M) F. The student will demonstrate an understanding of the special properties of the regular triangle, hexagon, octagon and square.

V. Develop an ability to calculate area and volume.

A. The student will be able to compute the area of the following:
(R) 1. Triangles.
(R) 2. Quadrilaterals.
(R) 3. Circles.

B. The student will demonstrate the ability to calculate the total surface area and lateral area of the following:
(M) 1. Right prisms.
(M) 2. Cylinders.
(M) 3. Spheres.
(M) 4. Polyhedrons.

C. The student will be able to compute the volume of the following:
(R) 1. Prisms.
(M) 2. Pyramids.
(M) 3. Cylinders and cones.
(M) 4. Spheres.
(ID) 5. Frustrum of a cone.
(ID) 6. Frustrum of a pyramid.

VI. Develop an understanding of the properties of circles.

(R) A. The student will be able to identify tangents, chords, secants, radii and diameters of a circle.
(R) B. The student will be able to compute the circumference of a circle.
(IM) C. The student will be able to coordinate the properties and relationships of tangents, chords, secants, radii, diameters and angles of a circle.

VII. Develop an understanding and use of a mathematical terminology.

A. The student will be able to add to his previous knowledge the following terms:

analysis	deductive reasoning
angle of depression	dihedral
angle of elevation	frustrum
angle symmetry	induction
apothem	inscribed polygon
circumscribed polygon	line symmetry
concentric circles	median of a triangle
conditional	major arc
converse	minor arc
convex	postulate
corallary	

Example of a Behavioral Instructional Objective:

Given $m\angle B = m\angle C$, prove $\triangle$ ABC is isosceles.

RESOURCES:

Books:

Text: Modern School Mathematics: Geometry - Houghton & Mifflin

Sample Texts:
Exploring Geometry - Holt, Rinehart & Winston
A First Course in Geometry - Singer
Geometry - Addison & Wesley

Geometry - Allyn & Bacon
Geometry - Harcourt, Brace and World
Geometry - Scott Foresman
Geometry: A Dimensional Approach - MacMillan
Geometry: A Unified Course - Merrill
Geometry: Plane and Solid - American Book Company
Geometry: Plane and Solid - Laidlaw
Modern Geometry - Holt, Rinehart & Winston
Plane Geometry - Ginn
School Mathematical Geometry - Houghton Mifflin
School Mathematics and Geometry - Houghton Mifflin

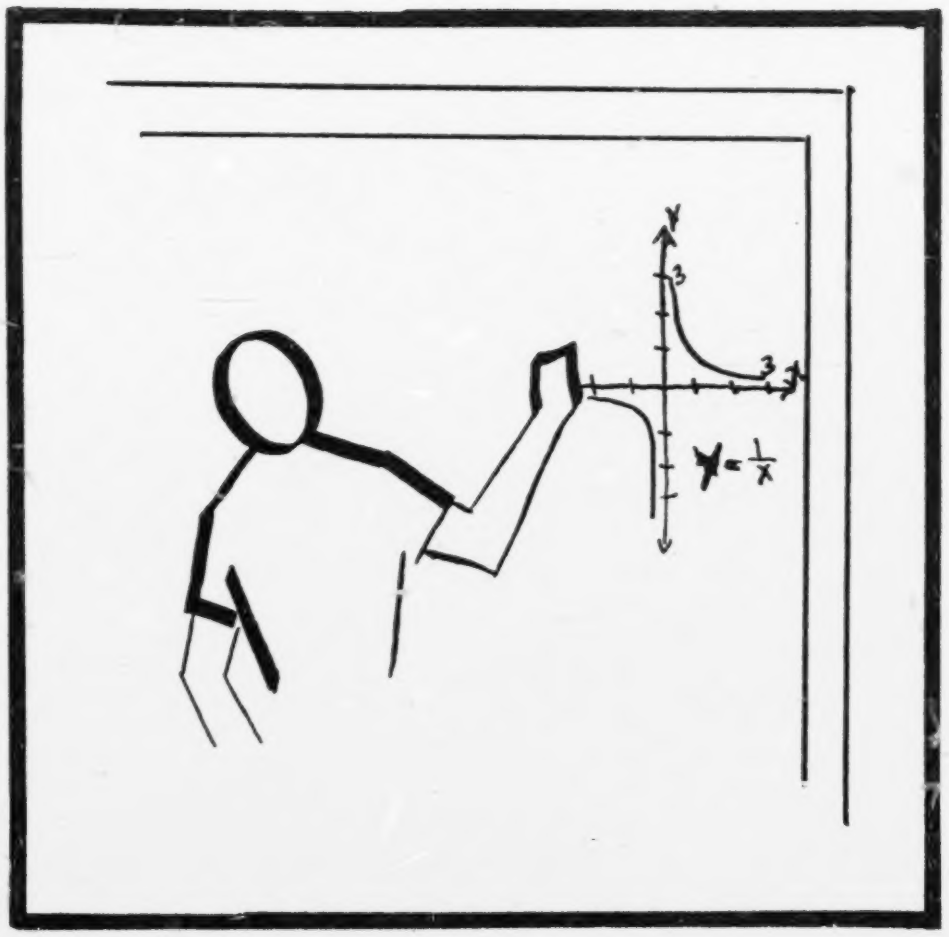
Library Books:
Mathematical Models - Cundy, H. Martin and Rollett, A. P., 510 Cun

Filmstrips:

Congruent Figures, 511
Angular Method, 513a (G)
Add and Subtract in Geometry, 513b (G)
Multiply and Division in Geometry, 513c (G)
Construction, 513e (G)
Similar Triangles - Experiment and Deduction, with guide, 513g-1 (G)
Parallelograms and Their Properties, with guide, 513h-1, (G)

Transparencies:

Unions, Intersections of Lines and Planes, 510 Uni
Measuring and Using the Circle, 510 Mea
Plane and Solid Figures, 510 Pla
Optical Illusions, 512 Opt
3-Dimensional Models, 513 Dim
Geometric Construction With Circles and Polygons, 513 Geo
Geometric Construction With Lines, Angles, Triangles, 513 Geo



ALGEBRA II

GRADE ELEVEN

ALBEGRA II

I. Develop an understanding of numbers and numerals.

(R) A. The student will demonstrate an understanding of set theory used in the field of real numbers.
(ID) B. The student will be able to prove the fundamental axioms of real numbers.
(ID) C. The student will demonstrate a knowledge of the axioms of the inequalities.
(M) D. The student will demonstrate an understanding of absolute value.
(M) E. The student will be able to work with algebraic expressions containing exponents which are real numbers.

II. Develop an understanding of number sentences.

(ID) A. The student will be able to find a term in an arithmetic sequence.
(ID) B. The student will be able to find a term in a geometric sequence.
(R) C. The student will be able to solve systems of linear equations in two variables.
(R) D. The student will be able to solve systems of linear inequalities in two variables.
(IM) E. The student will be able to solve a system of three linear equations and three variables.
(ID) F. The student will be able to graph linear equations in space.
(M) G. The student will be able to solve quadratic equiations by the following:
1. Completing the square.
2. Apply quadratic formula.
3. Factorization.
(ID) H. The student will demonstrate an understanding of the sum and product of the roots of quadratic equations related to the coefficients of the variable.
(ID) I. The student will be able to determine the nature of the root of a quadratic equation by using the discriminant.
(ID) J. The student will be able to solve quadratic inequalities.
(ID) K. The student will be able to use logarithms to solve equations.
(ID) L. The student will be able to use determinants to solve linear equations of two and three variables.
(M) M. The student will be able to solve fractional equations.

III. Develop an understanding of mathematical operations.

(IM) A. The student will be able to demonstrate an ability to add, subtract, divide and multiply complex numbers.
(M) B. The student will be able to add, subtract, divide and multiply polynomials.
(ID) C. The student will be able to perform multiplication, division, raising to a power, and extracting a root by using logarithms.
(ID) D. The student will be able to evaluate determinants through four rows and four columns.

IV. Develop an understanding of functions and relations.

(M) A. The student will be able to specify which relations are functions.
(R) B. The student will be able to graph functions and relations.
(M) C. The student will be able to calculate the slope of a line.

(M) D. The student will be able to determine the equation of a line given one of the three following:
1. Slope and y-intercept.
2. Slope and any point on the line.
3. Two points.

(ID) E. The student will be able to write and graph the inverse of a relation.

(M) F. The student will demonstrate an understanding of direct and indirect variation.

(M) G. The student will be able to identify and graph quadratic equations.

(M) H. The student will calculate the distance between two points using the distance formula.

V. Develop an understanding of trigonometry.

(ID) A. The student will be able to derive the six trigonometric functions by using the unit circle.

(I) B. The student will be able to identify the graphs of the trigonometric functions.

(ID) C. The student will be able to utilize the trigonometric tables.

(M) D. The student will be able to solve right triangles using trigonometric functions.

VI. Develop an understanding of polynomials.

(M) A. The student will demonstrate a workable knowledge of the law of exponents applied to multiplication, division, and power raised to a power of an algebraic expression.

(M) B. The student will be able to perform the four basic operations using polynomials.

(M) C. The student will be able to do the following factoring of polynomials:
1. Difference of two squares.
2. Sum and difference of two cubes.
3. Factoring by grouping.
4. Use of the remainder and factor theorems.

(M) D. The student, by the use of factoring, will be able to solve equations and inequalities.

(M) E. The student will be able to do the following in reference to rational expressions:
1. Simplification.
2. Sum and difference.
3. Quotient and product.

(ID) F. The student will be able to evaluate polynomial functions.

(ID) G. The student will be able to expand binomials by using the binomial theorem.

VII. Develop an understanding of permutations, combinations and probability.

(ID) A. The student will be able to determine the number of linear and circular permutations.

(ID) B. The student will be able to determine the number of combinations.

(ID) C. The student will be able to solve probability problems through the use of permutations and combinations.

VIII. Develop an understanding and use of mathematical terms.

(ID) A. The student will demonstrate an ability to add to his previous mathematical vocabulary the following terms:

amplitude of a periodic function
antilogarithms
angle of depression
angle of elevation
arithmetic sequence
arithmetic series
asympotes
circular function
characteristic of a logarithm
combinations
complex conjugate
complex number
conic section
cosecant function
cotangent function
coterminal angles
dependent event
determinant
ellipses
geometric series
hyperbolas
interpolation
inverse functions
logarithms
mantissa
matrix
minor of an element in a determinant
modulus
multiplicative identity
multiplicative inverse
permutation
point-slope form
prime polynomial
secant function
square matrix
trigonometrix functions
unit circle
zero of a function
zero matrix

Example of a Behavioral Instructional Objective:

Given $f(x) = ax^2 + bx + c$ the student will find the values of x where $f(x) = 0$.

RESOURCES:

Books:

Text: Modern School Mathematics: Algebra II and Trigonometry - Houghton & Mifflin

Sample Texts:
Algebra, Book II: Problem Solving - Houghton & Mifflin
Algebra II - Holt
Algebra II: A Modern Course - Merrill
Algebra II and Trigonometry - D. Van Nostrand
Algebra II & Trigonometry - Harcourt, Brace & World
Algebra II With Trigonometry - Allyn & Bacon
Fundamentals of Algebra: Book II - Allyn & Bacon
Modern Algebra: Book II - Ginn
Modern Intermediate Algebra - Holt, Rinehart & Winston
Modern Mathematics - MacMillian

Library Books:
Mathematics: The Alphabet of Science - Hawyard, Ruth and Willending, Margaret, 510 (A)
Mathematics in Everyday Things - Vergara, William, 510 (A)
Mathematics, Its Magic and Mastery - Bakst, Aaron, 510 Bak (NT)
Mathematics for the Modern Mind - Fuchs, Walter R., 510 Fuc (NT)

Filmstrips:

Slide Rules, 510.78 (NT)
Square Root and Cube Root, 511k, 512d (NT)
Exponents and Logarithms, 512v
Intruduction to Probability, 512m (A)
Sy' tems of Equations, 512r (NT)

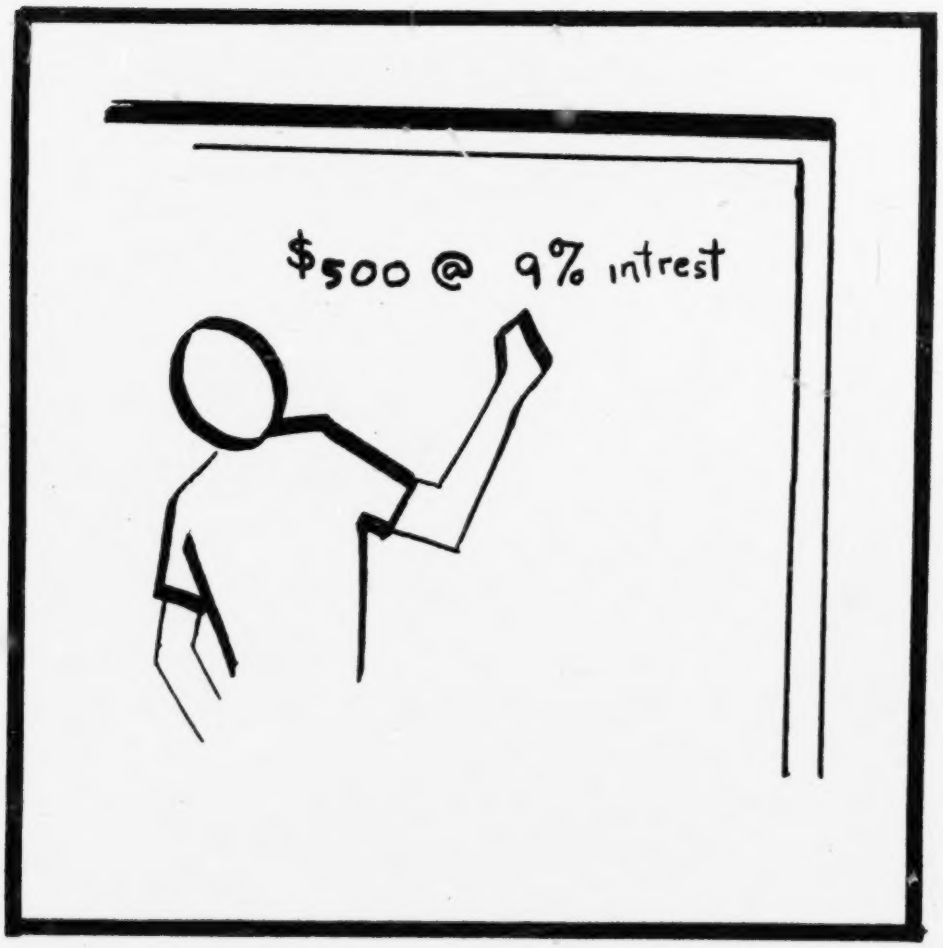
Quadratic Equations and Their Solutions, 512t (NT)
Line Functions, 514a (NT)

Transparencies:

Introduction to Probability, 510 Int
The Slide Rule, 510.78 Sli
Plots of Equations, 512 pl
Trigonometry, 514 Mon
3-Dimensional Drawings, 516

Filmloops:

Matrix Multiplication, 510



CONSUMER MATH

GRADE ELEVEN OR TWELVE

CONSUMER MATHEMATICS

I. Develop an understanding of the fundamental skills in business mathematics.

(M) A. The student will be able to apply addition, subtraction, multiplication and division as related to business problems.
(M) B. The student will use rational numbers in computing business problems.
(M) C. The student will use percent in business.

II. Develop an understanding of financial records and reports.

(ID) A. The student will prepare business records and reports.
(D) B. The student will prepare graphs of business data.

III. Develop an understanding of the mathematics of money and banking.

(D) A. The student will compute interest.
(D) B. The student will be aware of borrowing and lending money.

IV. Develop an understanding of the mathematics of distribution of goods and services.

(ID) A. The student will compute discounts in buying.
(D) B. The student will calculate prices, markons and percent of markon.
(D) C. The student will determine installment charges and interest rates on installment sales.
(D) D. The student will compute shipping charges.

V. Develop an understanding of the mathematics of investments.

(ID) A. The student will be aware of distributing income from investments.
(D) B. The student will practice purchasing and selling stocks and bonds.

VI. Develop an understanding of personal finance.

(D) A. The student will become aware of the costs involved in the ownership of an automobile.
(D) B. The student will become aware of the need for insurance.

VII. Develop an understanding of the practical measurements for the homeowner.

(M) A. The student will compute linear, square, and cubic measurements.
(D) B. The student will compute the costs of water, gas, and electricity.
(D) C. The student will be able to use the English and Metric systems.

VIII. Develop an understanding and use of mathematical terms.

(ID) A. The student will be able to add the following terms to his previous mathematical vocabulary:

assessed valuation	cash discount	markdown
balance sheet	commission	markon
bank discount	depreciation	sales tax
bank drafts	financial statements	scrap value
bank statement	installment buying	stocks and bonds
carrying charge	margin	T-accounts

Example of a Behavioral Instructional Objective:

Given $10,000, the student will invest this money in the stock market and at the end of three months determine a gain or a loss.

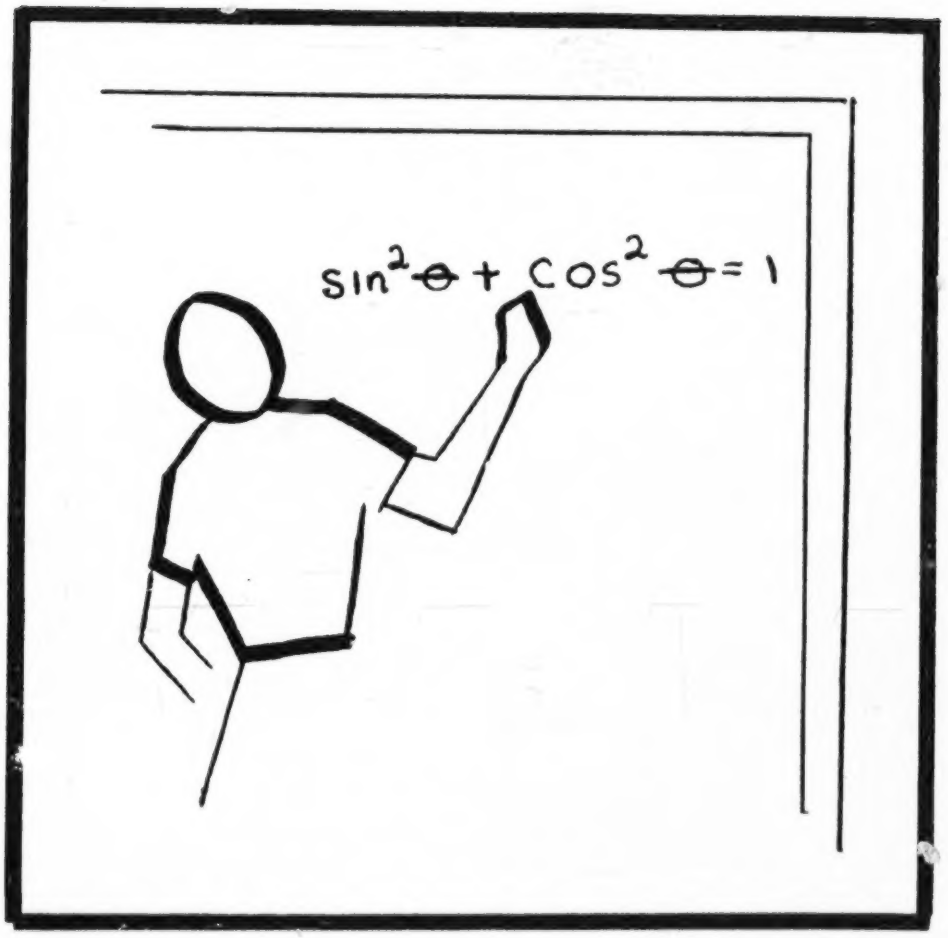
RESOURCES:

Books:

Text: Business Mathematics - 7th Edition - Gregg

Business and Consumer Arithmetic - 6th Edition - Olson and McNally; Prentice Hall

Mathematics for Business Occupations - 3rd Edition - Huffman, Twiss and Whale; Gregg



ADVANCED MATH

GRADE TWELVE

ADVANCED MATHEMATICS

I. Develop an understanding of circular functions.

(I) A. The student will become familiar with periodic functions.
(M) B. The student will derive the circular functions from the unit circle.
(ID) C. The student will be able to derive and verify the basic trigonometric identities.
(D) D. The student will be able to graph the circular functions.
(D) E. The student will be able to write and graph the inverses of the circular functions.
(D) F. The student will be able to solve open sentences involving circular functions.

II. Develop an understanding of trigonometric functions.

(M) A. The student will realize that the trigonometric functions are circular functions.
(R) B. The student will apply the trigonometric functions to the right triangle to obtain the trigonometric ratios.
(M) C. The student will be able to evaluate trigonometric functions by the use of a table.
(D) D. The student will solve trigonometric functions used in equations.
(ID) E. The student will be able to evaluate inverse trigonometric functions.
(ID) F. The student will solve equations containing inverse trigonometric functions.
(R) G. The student will apply the trigonometric ratios to solve right triangles.
(ID) H. The student will be able to solve triangles through the use of the law of sines.
(ID) I. The student will be able to solve triangles through the use of the law of cosines.
(ID) J. The student will calculate the area of a triangle using trigonometric functions.

III. Develop an understanding of plane analytic geometry.

(ID) A. The student will be able to represent vectors on a rectangular coordinate system.
(ID) B. The student will add and subtract vectors through the use of graphs.
(ID) C. The student will become familiar with the inner product of vectors.
(ID) D. The student will perform scalar multiplication.
(R) E. The student will derive an equation of a line.
(R) F. The student will calculate the slope of a line.
(R) G. The student will derive the distance formula.
(ID) H. The student will demonstrate an understanding of the polar coordinate system:
1. The student will graph polar equations.
2. The student will represent complex numbers in polar form.

IV. Develop an understanding of ordered fields.

(R) A. The student will review set theory used in mathematics.
(M) B. The student will prove axioms and properties of the real number field.
(R) C. The student will demonstrate a knowledge of absolute value and its application.

V. Develop an understanding of the concept of a limit.

(R) A. The student will review functions and relations.
(ID) B. The student will find the limit of increasing and decreasing sequences.
(ID) C. The student will become familiar with the operations of sequences.
(D) D. The student will find the sum of an infinite series.
(ID) E. The student will compute rates of change by differentiation.
(ID) F. The student will find the area bounded by a curve through integration.

VI. Develop an understanding and use of mathematical terms.

(ID) A. The student will demonstrate an ability to add to his previous mathematical vocabulary the following terms:

angle rotation
arccosine
arcsine
berring
calculus
closed interval
continuous function
convergent sequence
critical points
Decartes rule
differentiation
directrix
divergent sequence
equivalent vectors
finite sequence
infinite sequence
inflection points
integration
limit
magnitude
modulus of a complex number
non-decreasing sequence
non-increasing sequence
norm of a vector
periodic function
polar coordinates
quadrantal angle
radian
reference angles
resultant vector
scalar multiplication
standard angle position
summation notation
vectors
vector components

Example of a Behavioral Instructional Objective:

The student will prove $\sin^2 x + \cos^2 x = 1$.

RESOURCES:

Books:

Texts: Modern School Mathematics: Algebra II and Trigonometry - Houghton & Mifflin
Modern Trigonometry - Houghton & Mifflin
Modern Introductory Analysis - Houghton & Mifflin
Limits: A Transition to Calculus - Houghton & Mifflin

Sample Texts:
Advanced High School Mathematics - Merrill
Algebra II and Trigonometry - D. Van Nostrand
Algebra II and Trigonometry - Harcourt, Brace & World
Algebra II With Trigonometry - Allyn & Bacon
College Mathematics - Harper
Elementary Mathematics Analysis - Heath
Elements of Calculus - Addison Wesley
First Course in Calculus - Ginn

First Year Mathematics for College - MacMillian
Foundations of Advanced Mathematics - American Book Co.
Fundamentals for Advanced Mathematics - Holt, Rinehart & Winston
Modern Advanced Mathematics - Ginn
Modern Mathematics - MacMillian

Library Books:
What is Mathematics - Courant, Richard and Robbins, Herbert, 510 Cou (NT)
A Mathematician Explains - Logsdon, Mayne I., 510 Log (NT)

Filmstrips:

Mathematics Aviation - Wind Drift, 510 A (A)
Indirect Measruement, 510 (M)
Slide Rule, 510.78a (NT)
Trigonometry, 513d, (NT)
Vectors, 513f (NT & A)
Analytic Geometry, 516 (NT)
Line Functions, 514a (NT)

Transparencies:

The Slide Rule, 510.78 Sli
Plots of Equations, 512 Plo
Polar and Rectangular Coordinates, Part I, 513 Pol
Trigonometry, 514 Mon
Trigonometric Functions, 514 Tri
3-Dimensional Drawings, 516

Filmloops:

Vectors and Absolute Value, 510
Matrix Multiplication, 510

REVISION

This committee realizes that no curriculum guide can be complete and that constant revision is necessary, as student needs, teaching methods and materials change. Revision also provides an opportunity to incorporate the views of personnel not involved in writing a guide. The following instrument has been developed for the purpose of revision of this mathematics guide:

At your grade level:

1. Do the concepts listed correspond to the needs of the students? Explain.

2. Do the sub-concepts correspond to the maturity level of the students? If not, what do you suggest?

3. Are the behavioral sub-concepts helpful in developing the main concepts? If not, list those that need revision.

4. Is the content for your grade level or course too great or too little to be covered in the allotted time? What would you add or delete?

5. List those resources you would add or delete from the resource list.

6. Explain the teaching techniques and grouping procedures that you use in teaching mathematics.

7. Are you able to correlate the mathematics curriculum with other curricular areas? If so, explain.

8. Do you find that this curriculum guide is helpful to you in accomplishing your objectives for the grade level or course? Explain.

9. List other suggestions for improving the mathematics curriculum.

APPENDIX A

SURVEYING FORT BENTON'S MATHEMATICAL EFFORTS

Those staff members responsible for any portion of the Mathematics program were asked to respond to the attached survey instrument. The instrument is short and is composed of three parts. Each instructor was to indicate (1) the nature of the Math offerings at their level of instruction; (2) what the instructor considered to be the strengths of that offering; (3) what the instructor considered to be the weaknesses of that offering.

The feedback obtained from this instrument is summarized as follows:

1. Fort Benton's past areas of emphasis were:

K.....Seeing need for and use of math in daily life - discussions concerning numbers, money, geometric forms, fractions and units of measure.
1.....Sets, numeration system 1-100, Base ten, addition, subtraction, problem solving, math sentences, signs, fractions, geometry and terminology.
2.....Same as first grade with the addition of an introduction to multiplication and division, and some story problems.
3.....Exploring second grade work and adding graphing and tables, number systems, reasoning and proof, problem solving.
4.....Expanding third grade work and adding decimals, lines and measurements, closed curves, volumes.
5.....Whole numbers, base five, Roman numerals, geometry, fractions, decimals, measurement, graphs.
6.....Whole numbers, powers of ten, number systems, properties, base five, geometry, fractions, decimals, percent, metric system.
7.....Sets, whole numbers, geometry, rational numbers, base numbers.
8.....Rational numbers, geometry, metric system, variables, square root, solid geometry, relations and functions.
9.....Was individualized - review rational and whole numbers and basic operations of math.
10-12.....Advanced Algebra - math proofs, solving equations, order in set of real numbers, sequences and series, linear functions, polynomials and rational expressions, quadratic equations, complex numbers, exponents, trigonometry.
.....Geometry - reivew language of sets, basic definitions, lines, triangles, relation of triangle and all polygons, congruent triangles, special triangles, quadrilaterals,similar polygons, circles, construction, areas, and volumes.
.....General Math - basic geometric facts, counting and computing, statistics, algebra, compute income, managing income and construction.

2. Strengths:
   a) Kids receive introduction to a wide range of math.
   b) Basic concepts pretty well covered.
   c) Sequence seems to be acceptable.
   d) Responsibility of learning is on student in individualized effort.

3. Weaknesses:
   a) Some concepts too difficult for too many.
   b) There seems to be too much material for the less capable student in math.
   c) Not enough drill on basic number comginations.
   d) Too much stress placed on getting children ready for very advanced math.
   e) There is an inconsistency in presentation of concepts.
   f) As a result of not mastering basic facts at earlier levels, students many times do not receive exposure to certain concepts.
   g) Division seems to be a weakness at the 5th and 6th grade levels.
   h) Unless student is quite capable in math, he will become frustrated with the program.

SCHOOL SYSTEM SELV SURVEY

This survey is being distributed to those members of our staff responsible for any portion of our Mathematics program. Each teacher is asked to reply to all the statements.

Teacher's Name_____

Teacher's Grade Level_____

I. What is the nature of the Mathematics offering presently at your grade level? (i.e., what themes, concepts, ideas, etc. do you teach with reference to Mathematics during the course of the year?)

A. Major Themes or Topics.

B. Units

C. Concepts

D. Others

Comments:

II. What do you consider to be the strengths of this offering?

III. What do you consider to be the weaknesses of this offering?

APPENDIX B

CURRICULUM DEVELOPMENT SURVEY

Various college professors, learning laboratory representatives and State Department representatives were asked to respond to the attached instrument. The purpose was to obtain informative data in the English (Language Arts), Math, Science and Vo-Tech Curriculum areas. The instrument was designed to consider two major areas: (1) General information concerning the individual and agency that individual represented and (2) Specific curriculum information.

Thirty-one questionnaires were distributed; fourteen were returned. The following is an attempt to summarize the information:

-- It appears as if very few schools in the state are known to be developing curriculum guides at this time. Even though it was felt that many schools are beginning to do "something" in the realm of curriculum, the survey respondents did not for the most part indicate recommended places to visit. Of the programs and schools mentioned as doing "something" in curriculum, it appeared that all had a tendency to be striving toward some form of individualization in those curriculum areas they were concentrating on.

CURRICULUM DEVELOPMENT

This survey instrument is being circulated among college professors, learning laboratory representatives and State Department representatives. The purpose is to obtain informative data in the English (Language Arts), Math, Science, and Vo-Tech Curriculum areas. Your reply to this instrument will be greatly appreciated. Results will be sent to you upon request. A return self-addressed envelope has been enclosed for your convenience.

I. GENERAL INFORMATION

1. Name of Institution or Agency you represent_____

2. Describe the lines of communication you have with the local school districts in regard to curriculum development.

3. How many schools do you personally contact during the course of the year concerning curriculum development and improvement?

4. What is basically the area of concentration that you become involved with in your work with local school districts?

II. SPECIFIC CURRICULUM AREAS

1. Are you aware of any school districts that have developed or are in the process of developing curriculum guides or outlines in the areas of Language Arts, Math, Science and Vo-Tech? (If yes, please indicate)

2. Are there any school districts you would recommend a visitation to concerning their curriculum development? (If yes, please indicate where)

3. Are you aware of any worthwhile and interesting "new" happenings in the area of Language Arts - K-12? (If so, please relate)

4. Are you aware of any worthwhile and interesting "new" happenings in the area of Math - K-12? (Please relate)

5. Are you aware of any worthwhile "new" and interesting happenings in the area of Science - K-12? (Please relate)

6. Are you aware of any worthwhile "new" and interesting happenings in the area of Vo-Tech (Home Ec., Industrial Arts, Trades and Industry, Commercial, Vocational-Agriculture) (Please relate)

7. Do you have any lists of reference materials that you would share with us concerning any of these curriculum areas? (If so, please enclose list and return with questionnaire)

APPENDIX C

SURVEYING CURRENT PRACTICES IN MATHEMATICS

Various teachers and administrations were asked to respond to the attached questionnaire. The purpose was to obtain informative data concerning current practices in the Mathematics curriculum in the State of Montana. The questionnaire was designed to consider three major areas: (1) general information considering the school district; (2) organization of the program; and (3) nature of the offerings.

Twelve questionnaires were distributed; three were returned. The following information was obtained:

All schools replying indicated that they are primarily basing their math program on a textbook series. There seemed to be a weakness with the math programs common to those replying in the area of the computational skills. Supplemental material and reinforcement teaching were suggested to help alleviate this apparent weakness. It appeared that those replying felt their programs were primarily geared to the college-bound and advanced Math students, little practical math.

MATHEMATICS

This survey instrument is being circulated among school administrators and classroom teachers. The purpose is to obtain informative data in the Math Curriculum area in order to assist in the development of a Vertical Math Curriculum Outline. Your reply to this instrument will be greatly appreciated. Results will be sent to you upon request. A return, self-addressed envelope has been enclosed for your convenience.

I. GENERAL INFORMATION

1. Name of School System_____
2. Superintendent's Name_____
3. Number of Students in System_____
4. Approximately what percent of the Instructional budget is spent in the Math area?_____ Dollar amount?_____
5. Is there a district supervisor in Math? _____Yes _____No
6. Is there a district curriculum guide provided in Math? _____Yes _____No
7. How many members are on the total instructional staff?_____ How many of these teach in the area of Math?_____
8. Are there any well-established lines of communication between elementary and secondary Math teachers? _____Yes _____No
9. Is there a Department Head? _____Yes _____No
10. Comments:

II. ORGANIZATION

1. Does the Math Department K-12 have a written statement of its objectives? _____Yes _____No

2. Have your teachers from the various grade levels planned together to develop a sequential program in Math? _____Yes _____No (If so, briefly outline plan K-12)

3. Is the program evaluated at regular intervals and revised accordingly? _____Yes _____No

4. To what extent are mathematics courses available and suited to the ability and needs of your students?

5. To what extent are students electing mathematics courses beyond those that are required?

6. Comments:

III. NATURE OF OFFERINGS

1. What knowledges, skills and understandings are developed at each grade or each level of achievement?

K

1

2

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4

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8

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10

11

12

2. What offerings should be provided that are not included in the present program?

3. What offerings in the program seem less appropriate than formerly in light of present-day trends in mathematics?

4. How adequate is the content of offerings for developing the mathematical knowledge and skill needed by all students?

APPENDIX D

Reference Material

The following reference material was researched in an attempt to make this effort as dependable as possible. It was found that no one source provided us with the exact formula for our task. However, in searching through this reference material we were able to develop a curriculum outline we feel fits the needs of the students of Fort Benton.

1. Bernstein, Allen L., Trouble Shooting Mathematic Skills. New York: Holt, Reinhart and Winston, Inc., 1969.

2. Buchanan, Lexton, Limits: A Transition to Calculus. New York: Houghton Mifflin Co., 1966.

3. Butler, Charles H., The Teaching of Secondary Mathematics. New York: Mc Gram Hill, Inc., 1965.

4. Dolciani, Mary P., Modern Introductory Analysis. Boston: Houghton Mifflin Co., 1967

5. Dolciani, Mary P., Modern School Mathematics. Algebra I. New York: Houghton Mifflin Co., 1967.

6. Dolciani, Mary P., Modern School Mathematics. Algebra and Trigonometry II. New York: Houghton Mifflin Co., 1968.

7. Dolciani, Mary P., Modern School Mathematics 7. Boston: Houghton Mifflin Co., 1967.

8. Dolciani, Mary P., Modern School Mathematics 8. Boston: Houghton Mifflin Co., 1967.

9. Dunsheath, Robert, Mathematics Curriculum Guide. Clark County, Nevada, 1967.

10. Eicholz, Robert E., Elementary School Mathematics. Menlo Park, California: Addison Wesley Co., 1968.

11. Gronlund, Norman E., Stating Behavioral Objectives for Classroom Instruction. New York: MacMillan Co., 1970.

12. Gundlach, Bernard H., Understanding Numbers. River Forest, Illinois: Laidlaw Brothers, 1971.

13. Jurgensen, Ray C., Modern School Mathematics. Geometry. New York: Houghton Mifflin Co., 1969.

14. Keedy, Mervin L., Exploring Elementary Mathematics 1-6. New York: Holt, Rinehart and Winston, Inc., 1970-71.

15. Kinney, Lucien, General Mathematics, Book 2. New York: Holt, Rinehart and Winston, Inc., 1968.

16. Kinsella, John J., Secondary School Mathematics. New York: The Center for Applied Research in Education Inc., 1965.

17. Lynch, Ransom, A First Course in Calculus. Boston: Gin and Co., 1964.

18. Mager, Robert H. Ph.D., Preparing Instructional Objectives. Palo Alto, California: Fearon Publishing Co., 1962.

19. Morton, Robert Lee, Modern Mathematics Through Discovery. Morristown, New Jersey: Silver Burdett Co., 1970.

20. National Association of Elementary School Principals, Teaching Mathematics in the Elementary School. Washington D.C.: 1970.

21. Rosenberg, Robert R., Business Mathematics. New York: McGraw Hill Inc., 1968.

22. Sobel, Max A., Teaching General Mathematics. Englewood Cliffs, New Jersey: Prentice Hall, 1967.

23. Vance, Elbridge P., An Introduction to Modern Mathematics. Menlo Park, California: Addison Wesley Publishing Co., 1963.

24. Wooton, William, Modern Trigonometry. New York: Houghton Mifflin Co., 1969.